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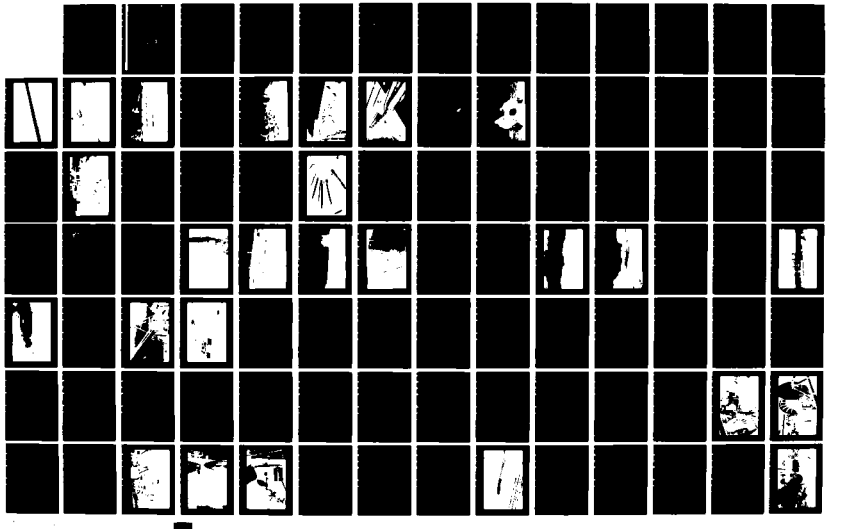

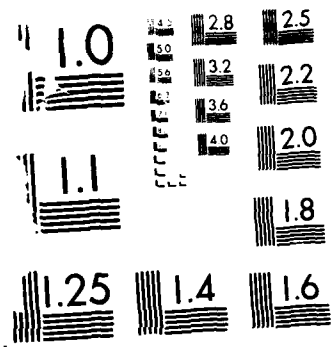

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FINAL REPORT ON THE INSTALLATION OF UNDERWATER POWER CABLE TO SMITH ISLAND AND CAPE FLATTERY LIGHTHOUSES

FPO-1-77(6)

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FINAL REPORT ON THE INSTALLATION OF UNDERWATER POWER CABLE TO SMITH ISLAND AND CAPE FLATTERY LIGHTHOUSES

FPO-1-77(6)
JANUARY 1977

OCEAN FACILITIES ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D. C. 20374

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1.0 OVERALL PROJECT DESCRIPTION

1.1 OVERVIEW

The Chesapeake Division, Naval Facilities Engineering Command (CHESNAV-FACENGCOM) provides support for the U. S. Coast Guard Lighthouse Automation and Modernization Program (LAMP). The goal of LAMP is the automation of Coast Guard lighthouses, thus permitting the removal of Coast Guard personnel from these outposts. CHESNAVFACENGCOM support for this project comprises the installation of underwater power cable to a number of these lighthouses, located offshore, which priorities and cost factors require to be powered from shore sources rather than from untended diesel generators in each light-house. CHESNAVFACENGCOM has already conducted feasibility studies, analyzed costs, investigated sites, surveyed cable routes, procured cable, furnished project management, and installed cable for several of the lighthouses being converted under this modernization program.

The project reported upon herein involved the installation of power cables to two lighthouses within the jurisdiction of the 13th Coast Guard District. This District, headquartered in Seattle, Washington, is in the process of automating two manned, offshore lighthouses, and in converting one offshore lighthouse presently unmanned to shore power.

1.2 INSTALLATION SITES

The manned lighthouses were on Tatoosh Island and on Smith Island; the former is off Cape Flattery at the entrance to San Juan Straits and the latter is located off Whidbey Island at the eastern end of the Straits in Puget Sound. The lighthouse that has already been automated, but which is to be converted to shore power, is located on Destruction Island; this island is off the west coast of Washington State about 50 miles south of Cape Flattery. Figure 1 shows the three sites.

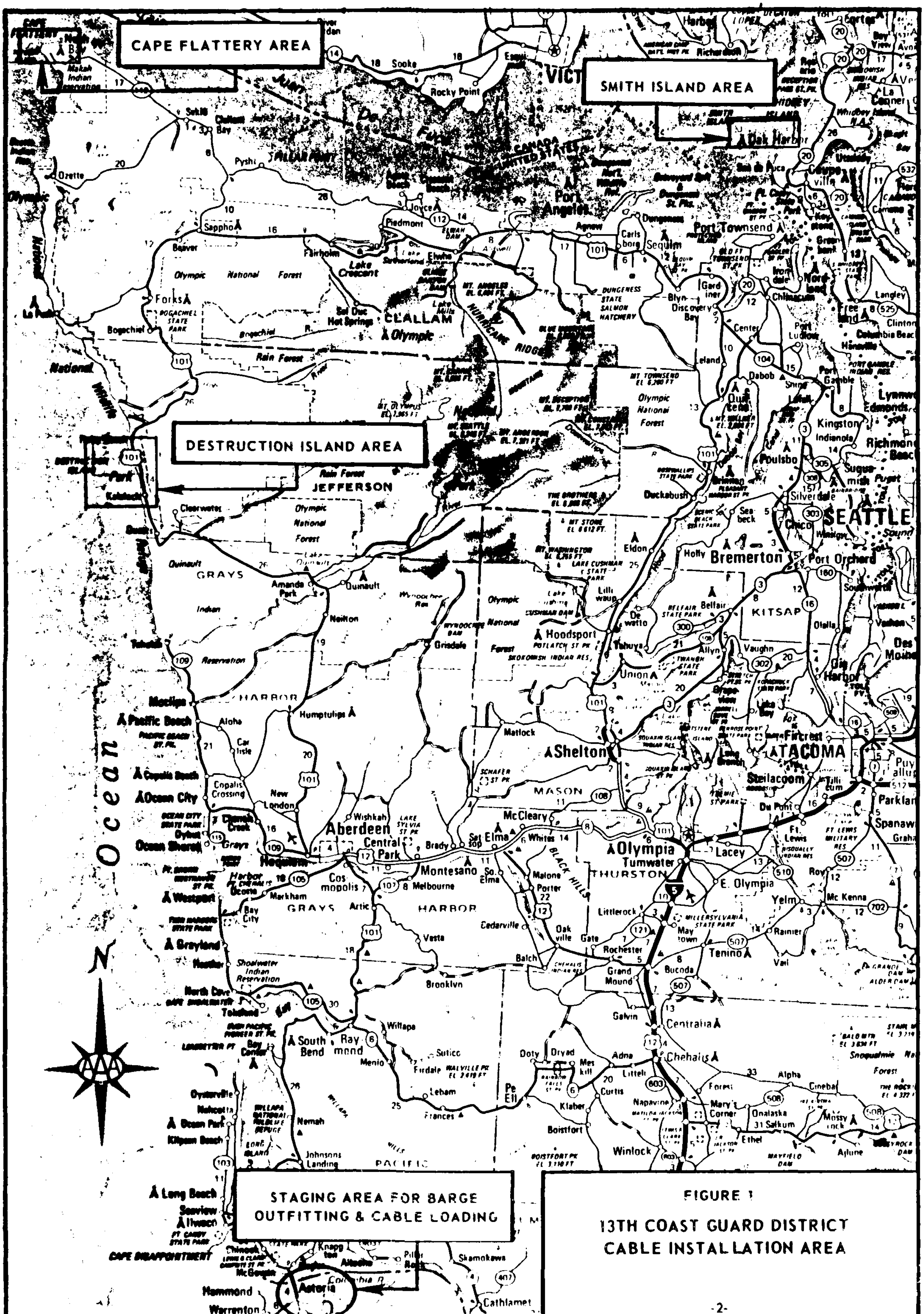


FIGURE 1
13TH COAST GUARD DISTRICT
CABLE INSTALLATION AREA

The tabulation below, extracted from the Coast Guard Light List, provides some additional description of the two lighthouses where shore power cable was installed. It was intended that this project should encompass power cable installations to all three of these lighthouses, but the Destruction Island installation was not attempted since the necessary permits were not issued in time to coordinate with the other operations.

(1) No.	(2) Name Characteristic	(3) Location Lat. N. Long. W.	(4) Nominal Range	(5) Ht. above water	(6) Structure Ht. above ground Daymark	(7) Remarks Year
		WASHINGTON				THIRTEENTH DISTRICT
2249 04778	Smith Island Light..... Fl. W., 15s	In east end of strait... 48 19.1 122 50.6	20	97	White square daymark on skeleton tower. 45	RADIOBEACON: Antenna 310 feet 355° from light tower. See p. XVIII for method of operation. 1858–1957
107 2220 04756	CAPE FLATTERY LIGHT..... Gp. Fl. W., R. sector, 45s 0.2s fl., 7.3s ec. 0.2s fl., 7.3s ec. 0.2s fl., 29.8s ec. 3 flashes.	On Tatoosh Island, south side of entrance to Strait of Juan de Fuca. 48 23.5 124 44.1	22W 18R	165	White conical tower on white sandstone dwelling. 65	Red from 164¾ to 171°, covers Duncan and Duntze Rocks. Light obscured from 271° to 007½°. RADIOBEACON: Antenna 290 feet 012° from light tower. See p. XVIII for method of operation. HORN, 2 blasts ev 60s (3s bl-3s si-3s bl-51s si). 1857

1.3 PRIOR PREPARATION FOR CABLE INSTALLATION

In preparation for the cable laying activities associated with this project, a site investigation at each of the three lighthouses was conducted during the week of 20 October 1975. The report of this investigation is given herein in Appendix B. Also, between 20 and 26 June 1976, the underwater cable routes for each of these sites were surveyed in accordance with the procedures described in Appendix A. In lieu of submitting the survey results in a separate report, data on the underwater cable routes applicable to the installation phase of the project are covered herein in the sections dealing with each individual site.

1.4 CABLE AND PROTECTION SYSTEMS

As delineated in Appendix B, the power cable length requirements for the three sites were approximated at: Cape Flattery - 40,000 feet; Smith Island - 34,000 feet; Destruction Island - 36,000 feet. The total, which includes a 10% allowance, is 110,000 feet.

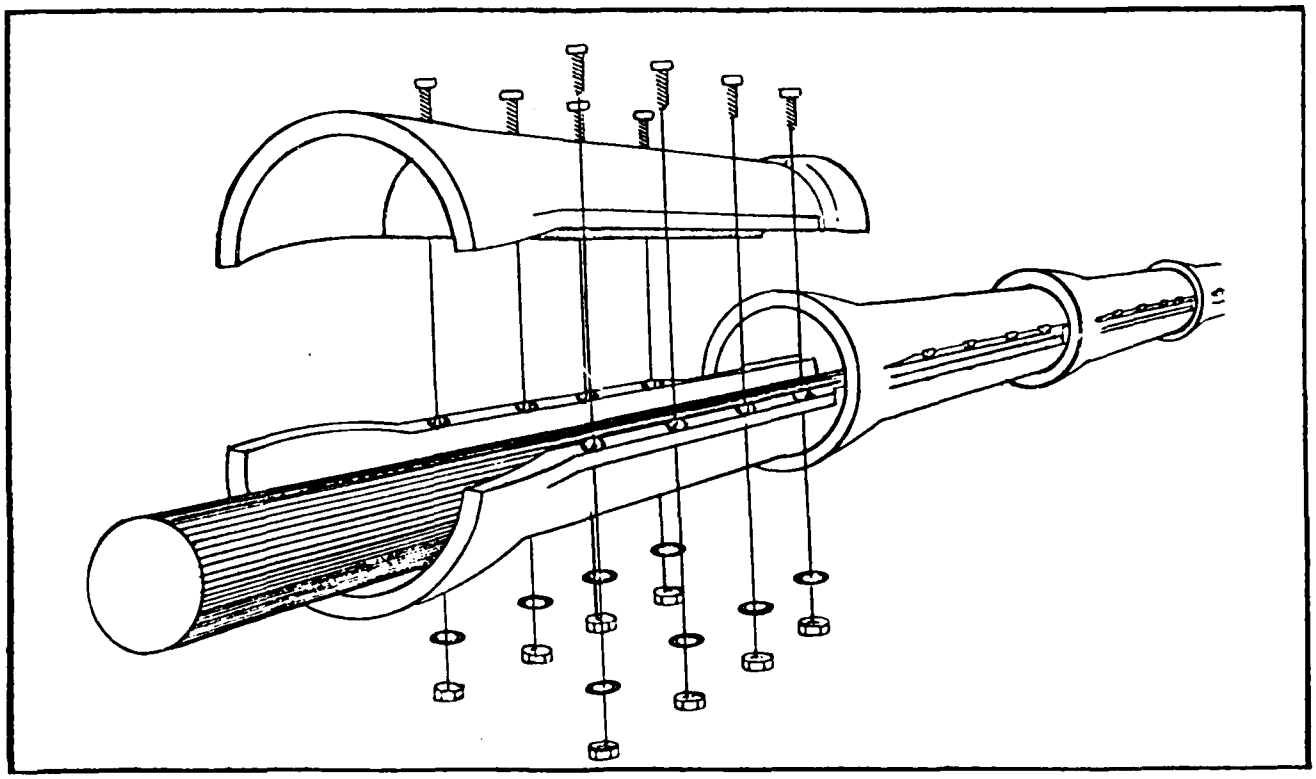
There was available some 100,000 feet of surplus armored coaxial communications cable (see Appendix B, Attachment 1, page B-8) which was determined to satisfactorily meet the power cable requirements. This cable was stored at the U. S. Coast Guard Base, Astoria, Oregon, on reels each approximately 3,000 feet in length. Some 80,000 feet of it was set aside for the Smith Island and Destruction Island installations. This cable was spliced at Astoria into one continuous length and stowed aboard the cable-laying vessel.

Additionally there was available some 53,000 feet of used, ITT, double armored power cable (see Appendix B, Attachment 2, page B-9) which was planned for use in the Cape Flattery installation. This cable was shipped to Astoria, Oregon for the project anticipating that only two splices would be required to provide the continuous 44,000 foot length. The excess cable was to be for contingency purposes.

A system for stabilizing and protecting cable running from a beach into deep water over a rocky bottom was worked out a number of years ago by Western Electric. Elements of the system are shown in Figure 2. The system consists

TYPICAL SPLIT PIPE FOR CABLE PROTECTION AND STABILIZATION

FIGURE 2



basically of encasing the cable inside a series of interlocking sections of split pipe and anchoring the pipe to the bottom with U-bolts or with threaded rock bolts running through the flange-bolt holes. The split pipe is of nodular cast iron; standard patterns are available with inside diameters of 3.5 or 5.0 inches and a length of three feet. Split pipe with an inside diameter of 3.5 inches was selected for this project and, because the cables were only 1.1 to 1.5 inches in diameter, flattened fire hose was used to shim and protect the cable inside the split pipe.

Each pipe section is made up of two flanged halves that can be bolted together to encase the cable. One end of each section is belled out to form a socket and the other end is shaped into a ball configuration to fit into the contiguous sections allowing an angular misalignment of about 7.5°. Many protection systems of this type have been installed by the Underwater Construction Teams (UCT) of the U. S. Navy Construction Battalions (Seabees) and the operation is now fairly standard practice for these groups. A team of UCT-2 divers from the 31st Naval Construction Regiment at Port Hueneme, California was assigned to this project to perform the cable stabilization work.

The technique used for installing the fire hose shim material is shown in Figure 3. One flattened hose was placed in a series of split pipe halves as they were assembled in interlocking fashion below the cable. The cable then was moved into this series of pipe halves to lay atop the fire hose. Next, a second layer of fire hose was fitted into the pipe sections to cover the cable. Finally, mating sections of split pipe were bolted to the lower halves to complete the stabilization system as shown in Figure 4. (The tools required for assembling the top and bottom halves of split pipe are also shown in Figure 4.) Instead of the U-bolts used occasionally, two threaded rock bolts were used to secure each split pipe section to the bottom.

Some one hundred lengths of split pipe, and a corresponding amount of fire hose shim material, were stowed at the beach sites after trucking from Astoria as shown in the photograph, Figure 5.

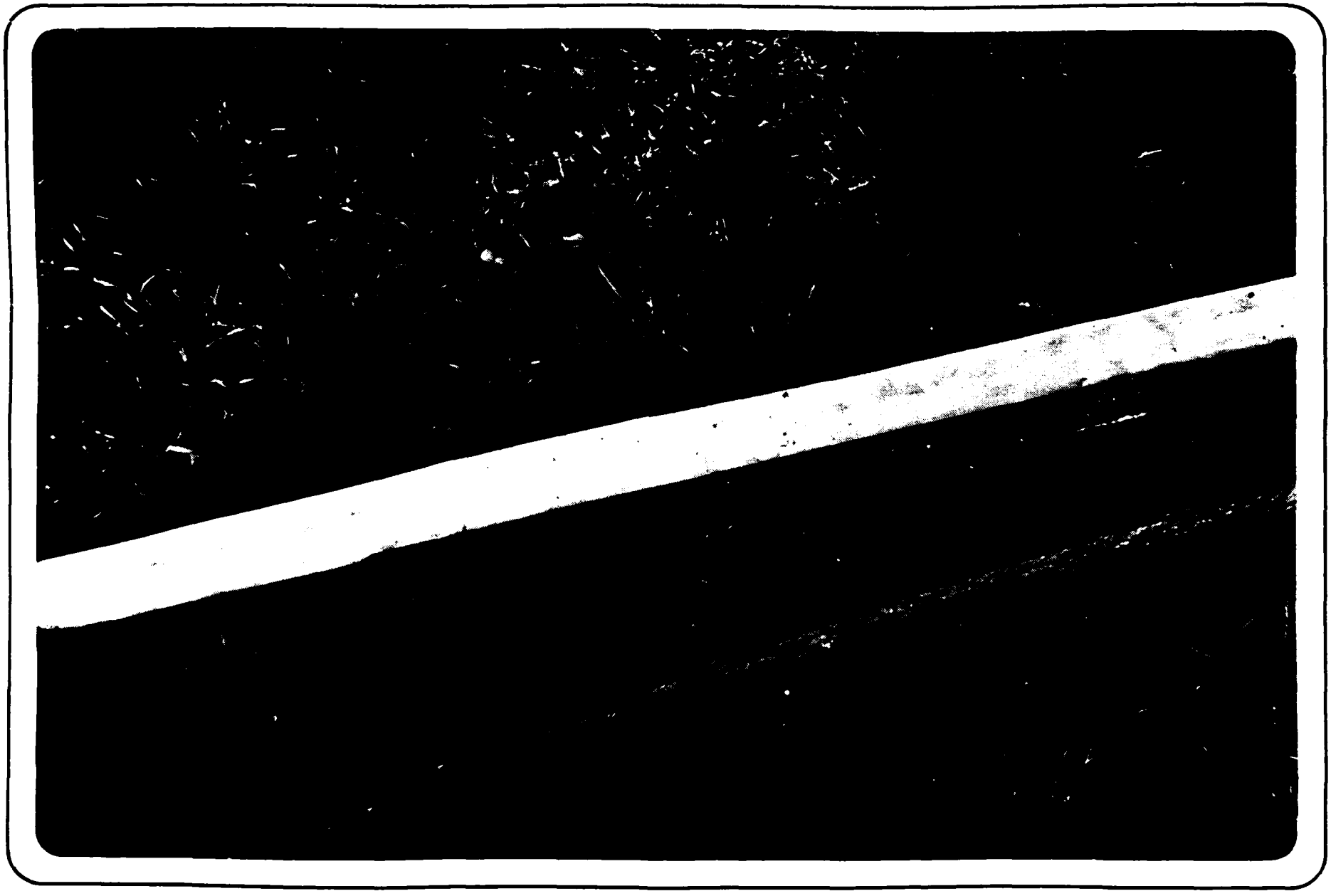


FIGURE 3: FIRE HOSE SHIM MATERIAL AND CABLE IN SPLIT PIPE HALVES

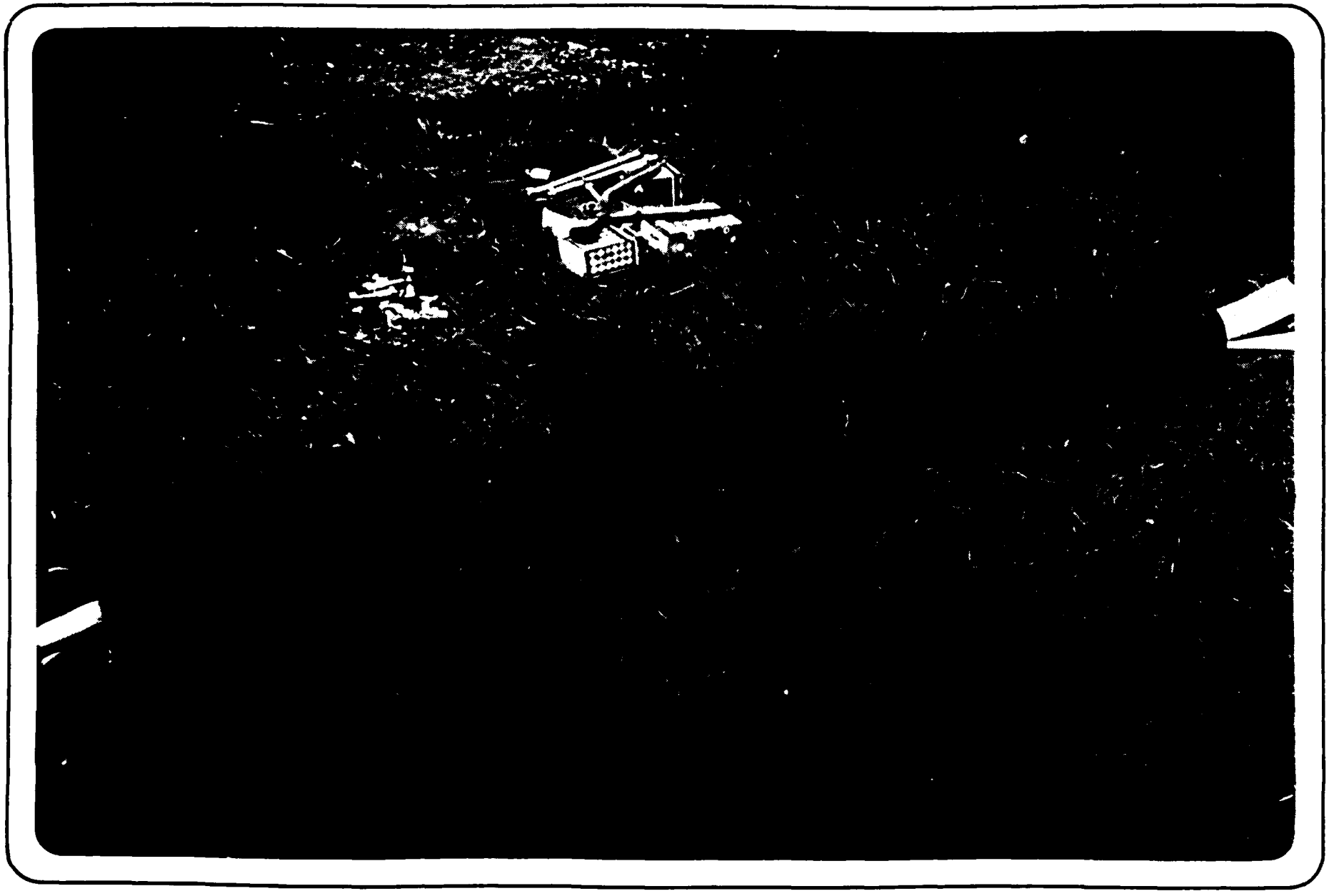


FIGURE 4: ASSEMBLED LENGTHS OF SPLIT PIPE AND TOOLS FOR BOLTING

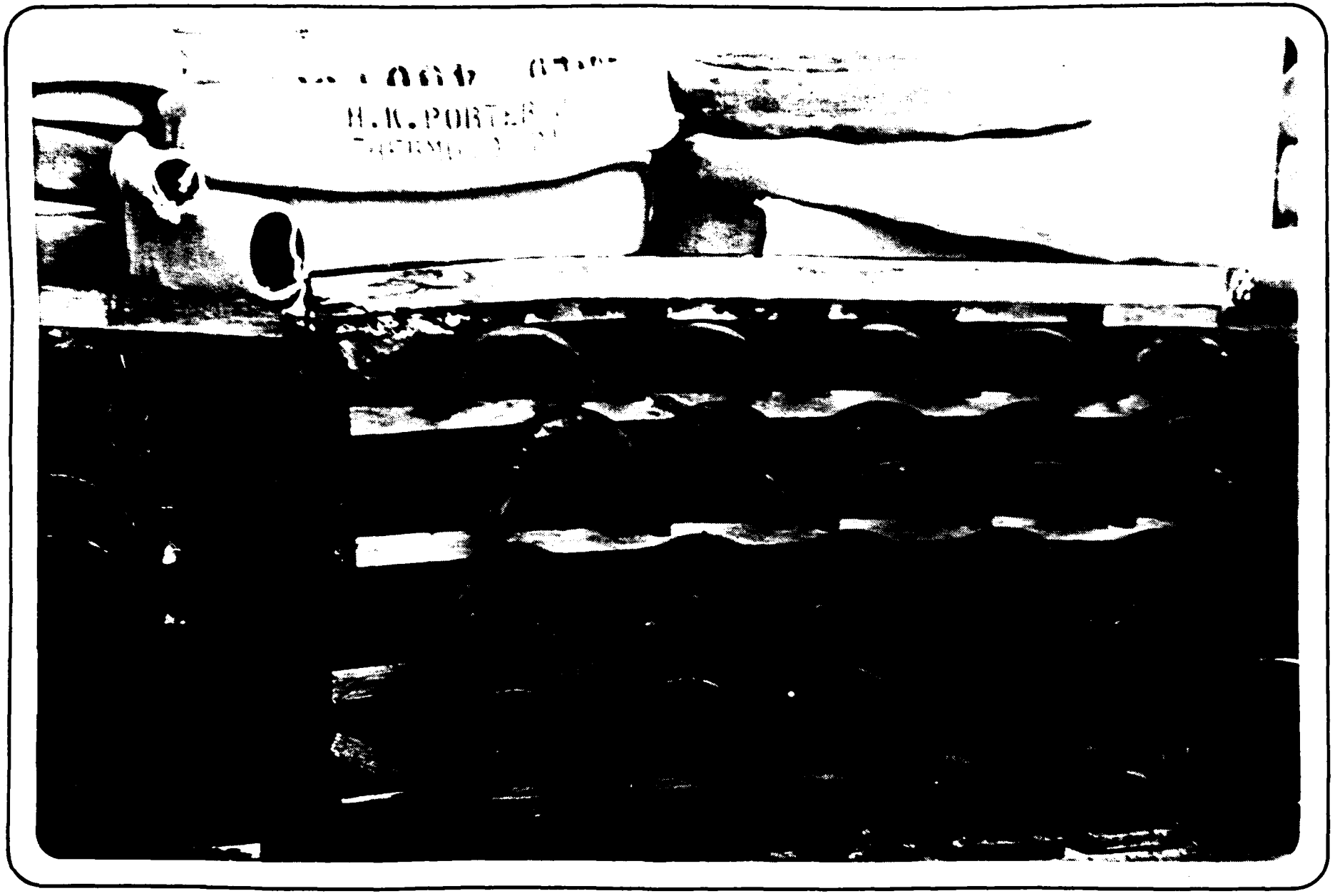
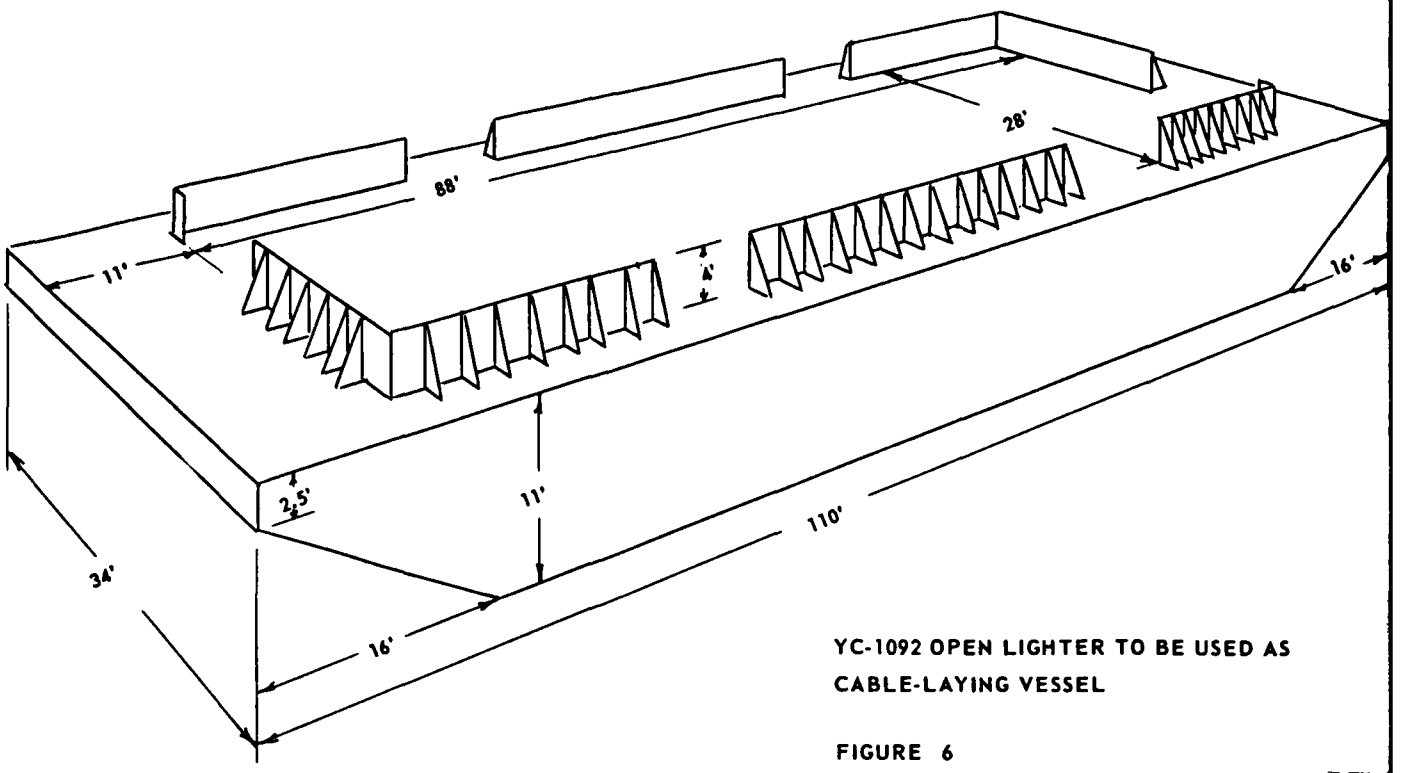


FIGURE 5: SPLIT PIPE AND SHIM MATERIAL STOWED AT BEACH SITE



YC-1092 OPEN LIGHTER TO BE USED AS CABLE-LAYING VESSEL

FIGURE 6

1.5 CABLE-LAYING PLATFORM AND SUPPORT VESSELS

The cable-laying platform was a 500-ton open lighter, designated YC-1092. This vessel, Figure 6, on loan from the Naval Torpedo Station, Keyport, Washington, was towed by the Coast Guard Cutter *IRIS* to the U. S. Coast Guard Station at Astoria, Oregon to be modified for cable-laying and to have loaded aboard the gear necessary for the operation.

This 110 foot x 34 foot x 11 foot lighter has an open deck area 88 feet x 28 feet that is surrounded by a four foot high bulwark, stiffened on the outboard side to form a clear space without obstructions for stowage of the cable and other gear required for the operations. The cable-laying gear installed in the after end of this open space consisted of a Cable Laying and Maintenance Machine, CLAMM, developed by the Coast Guard, and a Jacobson Brothers' non-powered cable tensioner loaned to the Coast Guard for this project. Both of these cable-laying devices are described in Appendix C and are shown in position on the YC-1092 in Figure 7.

The forward 58 feet of the space between bulwarks was occupied by the cable looped into 21 layers with 48 cable loops per layer, Figure 8. Over the center of the stowed cable, a sheave was hung from a cable-stayed steel frame that spanned the open space. During the laying operation the cable was to pass from the stowage area, up and over the suspended sheave, through the tensioner back-up brake system and chute down over the stern into the water, Figure 9. Variations on this system will be described in greater detail in a later section.

FIGURE 7: THE CLAMM AND THE CABLE TENSIONER INSTALLED ABOARD THE YC-1092

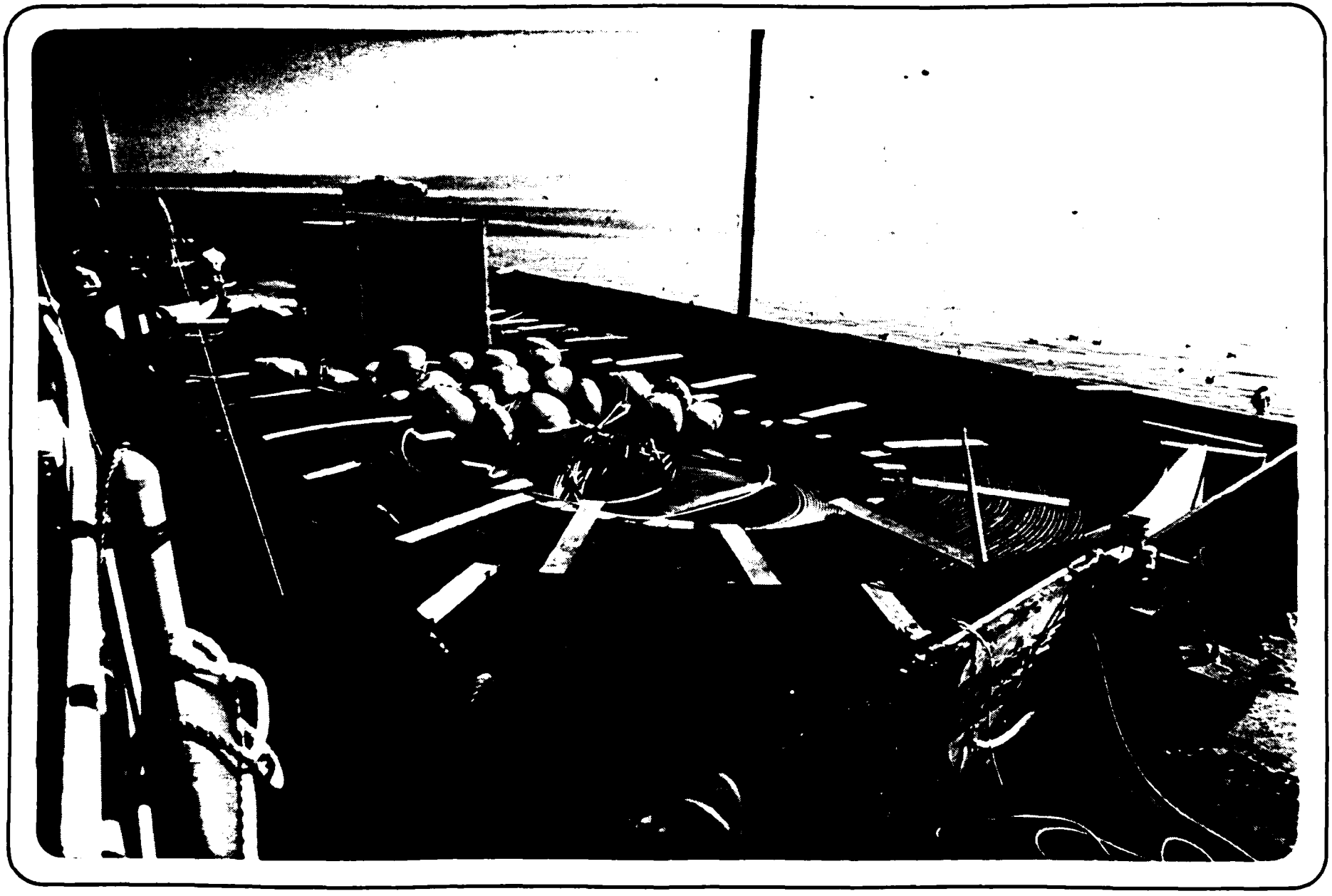


FIGURE 8: ARRANGEMENT OF THE CABLE BIN ABOARD THE YC-1092

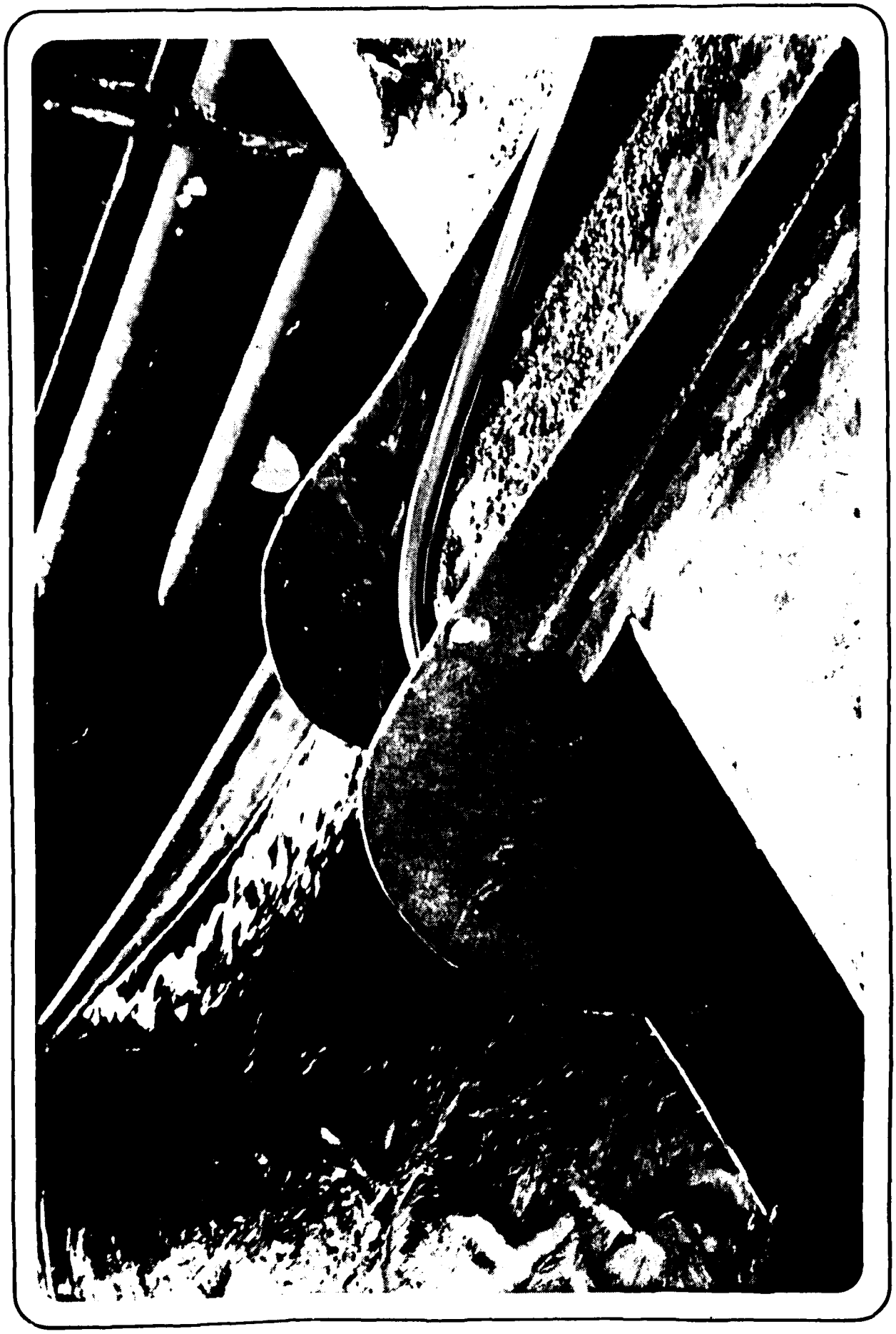
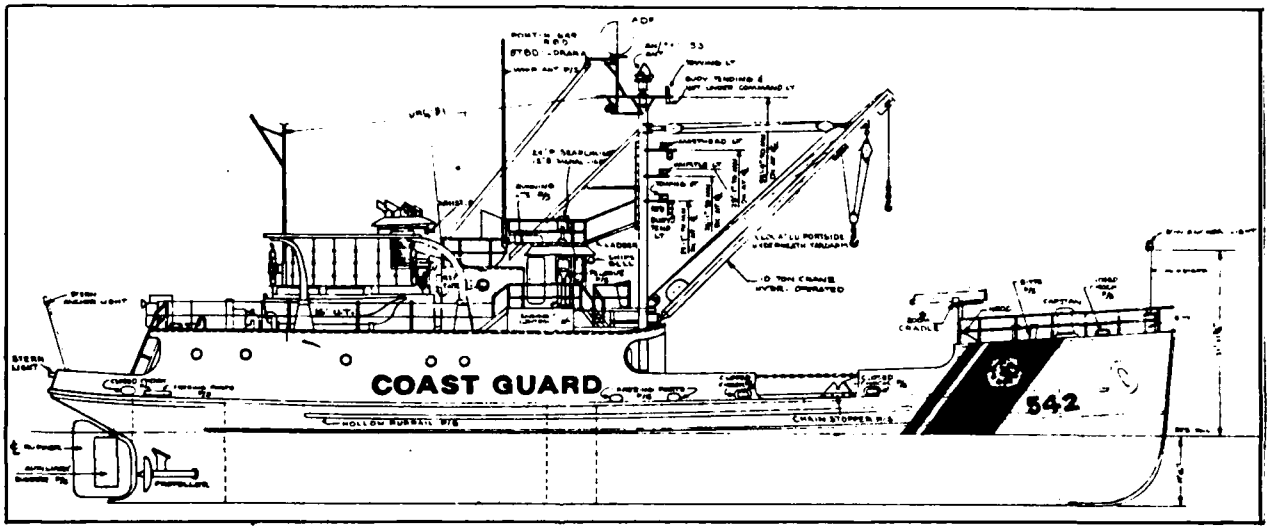


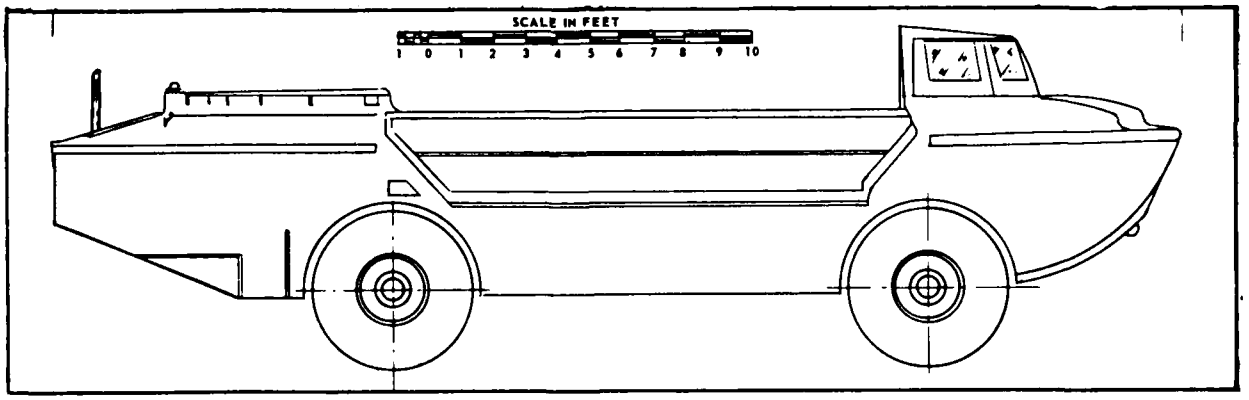
FIGURE 9: CABLE CHUTE OVER THE STERN LOG OF THE YC-1092

The U. S. Coast Guard Cutter *POINT COUNTESS*, WPB-82335, arrived in Astoria, Oregon and provided support for the YC-1092 during the outfitting stage. However, it was replaced as project support vessel prior to leaving Astoria by the U. S. Coast Guard Cutter *WHITE BUSH*, WLM-542. This coastal buoy tender, Figure 10, has an overall length of 133 feet, a beam of 31 feet, and a draft of 9 feet. When the twin screws are driven at maximum RPM by its two 600 horsepower diesels it attains a speed of 9.8 knots. This vessel served both as a tug for towing the YC-1092 and as a cable-laying vessel during the Cape Flattery installation.



USCGC WHITE BUSH, WLM-542 FIGURE 10

The Navy assigned to this project a *LARC V* amphibious craft, Figure 11, and an inflatable *ZODIAC* craft, Figure 12. Details on the *LARC V* are given in Appendix D. This craft was transported to all sites by a wide-bed lowboy truck and trailer which were brought from Port Hueneme for this purpose. The Coast Guard provided a 41 foot search and rescue boat, *SAR*, for use during the operation.



LIGHTER, AMPHIBIOUS, RESUPPLY, CARGO: LARC V FIGURE 11

FIGURE 12: A ZODIAC ASSIGNED BY THE NAVY TO THE PROJECT

The 16-foot Boston Whaler carried aboard the *WHITE BUSH* was also available as needed. General characteristics of this latter craft can be extracted from the data given in Appendix D.

OVERALL SCHEDULE OF OPERATIONS

FIGURE 13

OPERATION	DATES
SITE INVESTIGATIONS AT CAPE FLATTERY, DESTRUCTION ISLAND, AND SMITH ISLAND LIGHTHOUSES	21-24 OCT 1975
SELECTION AND TESTING OF POWER CABLE FOR THREE LIGHTHOUSE SITES	1 NOV-1 DEC 1975
SUBMISSION OF REQUESTS FOR PERMITS AND RIGHTS OF WAY FOR CABLE INSTALLATIONS	1 JAN-1 MAR 1976
CABLE ROUTE SURVEYS AT CAPE FLATTERY, DESTRUCTION ISLAND, AND SMITH ISLAND LIGHTHOUSES	20-26 JUN 1976
DETERMINATION OF METHODS OF PLACEMENT AND CABLE-LAYING TECHNIQUES	1 JUL-1 AUG 1976
FINALIZATION OF PERMITS FOR CAPE FLATTERY AND SMITH ISLAND LIGHTHOUSE SITES	1 AUG 1976
YC-1092 ARRIVES ASTORIA FOR OUTFITTING, LOADING AND SPLICING OF CABLE	17 AUG 1976
WHITE BUSH TOWS YC-1092 TO PORT ANGELES TO PREPARE FOR FIRST CABLE LAY	5 OCT 1976
SURPLUS COMMUNICATIONS CABLE INSTALLED FROM SMITH ISLAND TO WHIDBEY ISLAND	9 OCT 1976
WHITE BUSH TOWS YC-1092 FROM WHIDBEY ISLAND TO NEAH BAY	11 OCT 1976
ITT CABLE INSTALLED BETWEEN CAPE FLATTERY LIGHTHOUSE, TATOOSH ISLAND AND NEAH BAY	14-15 OCT 1976
PRELIMINARY CABLE PROTECTION AND STABILIZATION BY UCT-2 SEABEES AT TATOOSH ISLAND	18-22 OCT 1976
SHORE END CABLE PROTECTION AND ELECTRICAL CONNECTIONS COMPLETED BY COAST GUARD AT SMITH AND WHIDBEY ISLANDS	3 NOV 1976
SMITH ISLAND LIGHTHOUSE COMMENCES OPERATION UNDER SHORE POWER	3 NOV 1976
SHORE END CABLE PROTECTION AND ELECTRICAL CONNECTIONS COMPLETED BY COAST GUARD AT TATOOSH ISLAND AND NEAH BAY	18 DEC 1976
CAPE FLATTERY LIGHTHOUSE COMMENCES OPERATION UNDER SHORE POWER	19 DEC 1976

1.6 OVERALL SCHEDULING OF THE PROJECT

The schedule given in Figure 13 represents the current status of this project. General scheduling of the operation is covered here with additional details provided in the later coverage of each operational aspect.

2.0 ORGANIZATIONAL RESPONSIBILITIES

2.1 CHESNAVFACENGCOM

The Chesapeake Division of the Naval Facilities Engineering Command is under an interagency agreement with U. S. Coast Guard Headquarters in Washington, D. C., to provide underwater power cable installations for various Coast Guard districts. For the cable installations to Smith Island and Cape Flattery CHESNAVFACENGCOM provided:

- o Overall project engineering, management, and coordination.
- o Inter-communication between all project participants.
- o Navigation procedures.
- o A project manager, assisted by a CHESNAVFACENGCOM engineer.
- o Documentation, including this final report.

2.2 13TH COAST GUARD DISTRICT

The 13th Coast Guard District was actively involved in the support of all phases of this project. For the cable installation, the 13th Coast Guard District performed the following:

- o Provided the support of various Coast Guard Stations within the District and District Headquarters.
- o Towed the cable-laying platform from Keyport to Astoria, Oregon for loading cable and from Astoria to the installation sites.
- o Acquired permits and rights of way as necessary.
- o Provided navigational equipment (on loan from NOAA).
- o Outfitted the cable-laying platform, including the CLAMM.
- o Spliced and loaded the cable aboard the platform.
- o Towed the cable-laying platform during cable-laying operations.
- o Provided additional support vessels as required.
- o Was responsible for burying and/or protecting the cable at each cable landing site, from water level up the beach to the lighthouse or the power source.
- o Provided site clearances for access to the lighthouse islands and the proposed shore power terminal areas.
- o Provided a representative to serve as liaison between the Coast Guard and Navy (CHESNAVFACENGCOM and UCT-2).

- o Provided specific miscellaneous items such as fire hose or other material to shim the cables inside the split pipe.
- o Spliced the ITT cable installed at the Cape Flattery site.

2.3 UNDERWATER CONSTRUCTION TEAM-TWO (UCT-2)

UCT-2 supported the cable-laying operations as follows:

- o Provided a 12-man diving and construction team with the necessary diving, other support equipment, and supplies.
- o Provided a LARC V Amphibious Craft for use as a diving and construction platform and for assistance during cable-laying.
- o Provided personnel to assist with cable-laying and navigation.
- o Notified 13th Coast Guard District of quantity of fire hose required to shim both the 1.5" and 1.1" diameter cables inside the 3.5" split pipe.
- o Protected and stabilized the cable as required at each of the shore approaches.
- o Provided specific equipment such as rock bolts and the equipment and supplies to "rock bolt" the split pipe assemblies; reusable float balloons; etc.
- o Provided navigation equipment, such as a portable depth recorder, transits (2), and tripods for transits (2).
- o Prepared a written report (with underwater photographs) of the diving aspects of the installation.

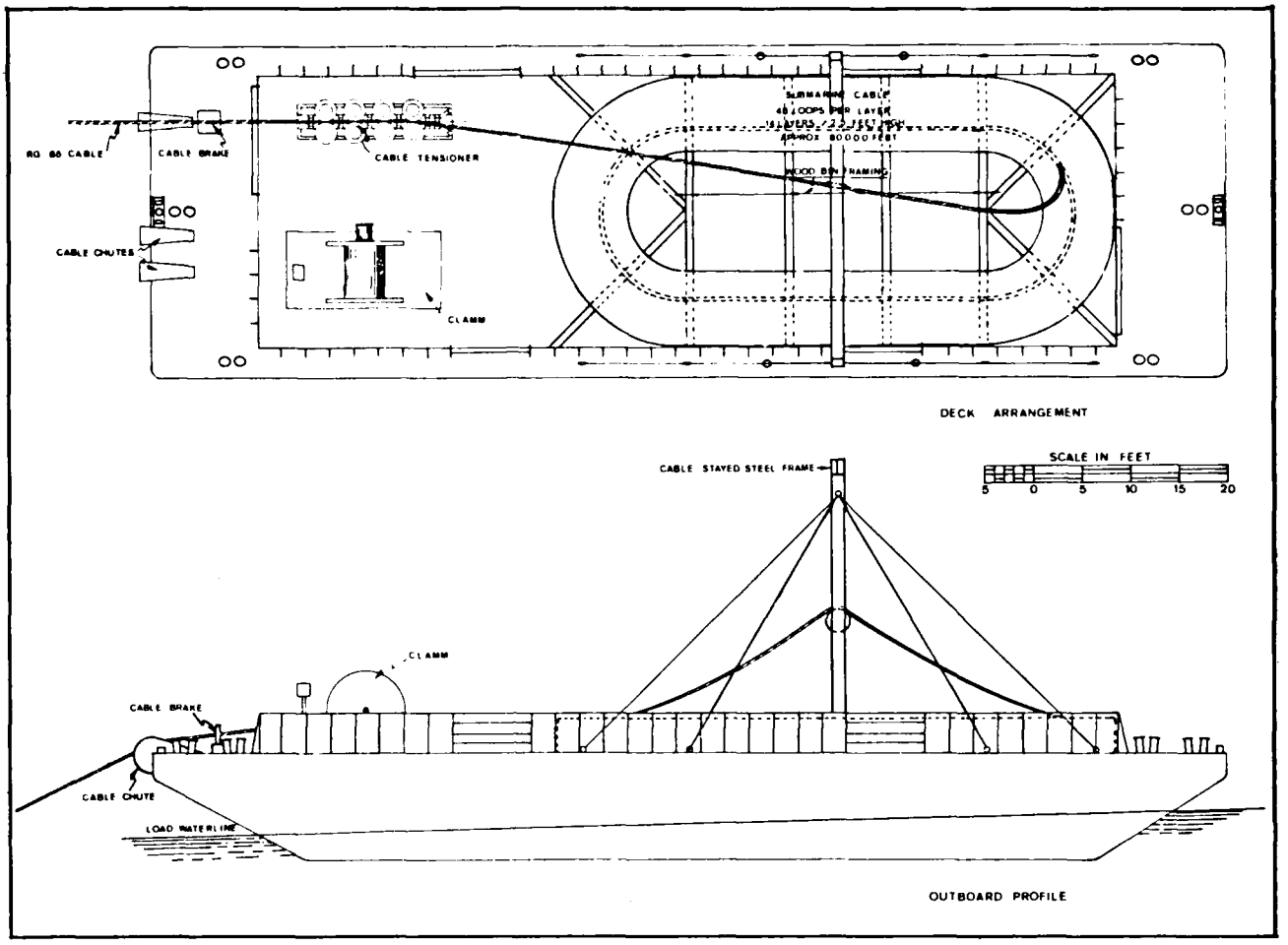
3.0 OUTFITTING AND LOADING THE CABLE-LAYING PLATFORM

3.1 INSTALLATION OF CABLE-LAYING EQUIPMENT

The equipment required aboard the YC-1092 for cable-laying operations is best described by reference to Figure 14. A steel H-beam frame was constructed by the Coast Guard at Astoria and installed 29 feet aft of the forward bulwark. The two 30-foot high legs are bolted to the deck outboard of the bulwark and are each stayed fore and aft by steel cables. The 31-foot long cross beam, which spans the cable bay, has welded end plates drilled with holes for

YC-1092 RIGGED FOR CABLE-LAYING

FIGURE 14



attachment bolts to secure the beam to the vertical legs at a series of different heights above the deck. This permits the sheave, which is suspended from the center of the cross beam, to be positioned vertically for optimum alignment of the cable.

Prior to installing the H-beam frame the barge was cleared of all debris. All deck fittings within the area surrounded by the bulwark were cut away and welds ground smooth. All tanks were inspected, pumped dry, and manhole covers secured. Any remaining wood sections covering the bulwark openings were removed and stored ashore.

The Cable Laying and Maintenance Machine, CLAMM, described in Appendix C, was located on the deck, six feet off centerline to starboard as shown in Figure 14, with the level-wind fairlead on the after side, and securing legs installed. Since the CLAMM was required for the cable-loading operations, it

was not actually placed aboard until after the cable loading was completed.

A commercial cable tensioner, also described in Appendix C, was installed about nine feet off centerline on the port side, in line with the removable portion of the bulwark. Due to time limitations and requirements for modifications to the tensioner it was not installed until 7 October 1976 after the YC-1092 had reaced Port Angeles.

Three cable chutes, provided by the Coast Guard, were installed along the after rake and deck edge. As indicated in the drawing, one chute is just off centerline, braced and secured beside the chock and bitts so that these fittings are accessible; this chute is aligned with the CLAMM gypsy head. The second chute is off center to starboard and is welded flush to the deck; it aligns with cable being payed out across the CLAMM drum and through the CLAMM fairlead. The third chute is also welded flush to the deck. It is in line with cable being payed out through the cable tensioner.

A cable brake, furnished by the Coast Guard along with the CLAMM, was installed between the cable tensioner and its cable chute. The brake was supported off the deck so as to be in line with the cable as it passed through the tensioner and overboard through the chute. Since this brake proved ineffective it was not utilized during the cable-laying operations.

All necessary navigation lights, including running lights, anchor lights, and towing lights, were installed by the Coast Guard. It may be noted that, because of the trim the vessel assumed when the cable was loaded forward, the platform was towed astern from Astoria to Port Angeles. However, it was towed ahead during cable-laying operations. Necessary adjustments in navigation lights required for these two operational modes was made when the light system was installed. Floodlights were also provided as required for nighttime operations.

3.2 PREPARATION OF PLATFORM TO STOW CABLE

As shown in Figure 14, the cable stowage bin covers the forward 58 feet of the main deck area enclosed by the longitudinal bulwarks and the forward transverse bulwark. The outer loop of the cable has straight runs of 30-feet fore and aft along the inside of the longitudinal bulwarks connected by semicircular runs, of 14-foot radius, at the forward and after ends. These semicircular ends of the cable bay were fitted with curved plywood bulwarks as

shown in Figure 15. The inner loop of cable has straight runs of 30-feet fore and aft spaced 12-feet apart connected by semi-circular runs, of 6-foot radius, at the forward and after ends. Assuming a two inch center spacing of the cable loops this arrangment accommodates 48 loops per layer. The outer loop length is 147 feet of cable and the inner loop is 98 feet of cable. There were 14 layers of cable.

The bottom layer of cable was supported off the deck by 2 x 4 timbers laid flat. A complete deck of 1/2 inch plywood was constructed above these support timbers to compensate for irregularities in the deck. As shown in Figure 14, the support timbers comprised four 28-foot lengths running athwartships between the bulwarks and four 19-foot lengths running diagonally along the deck. Diagonally braced vertical timbers were erected at each of the four corners to configure the outer plywood around the outer loops; these were braced from the bulwarks as necessary. The inner loop of the first layer was configured around blocks nailed to the plywood decking. For successive layers, temporary verticals were attached to the base units so that they extended slightly above each layer as it was laid to ensure control of the configuration of the inner loop of the layer.

The layers of cable loops were separated with 12 inch widths of 1/2-inch plywood, each 8-feet long, and spaced about every ten feet between the layers of cable loops. This called for some 160 strips of plywood cut from forty four-by-eight foot sheets.

3.3 CABLE SPLICING, CHECKOUT, AND LOADING ABOARD THE PLATFORM

For the cable loading operation, the CLAMM was utilized to unreel the surplus communications cable from the individual reels and to feed it aboard the YC-1092 where it was manhandled into the prescribed stowage configuration. The CLAMM was positioned at the side of Pier 2 at the U. S. Coast Guard Base, Astoria, Oregon with the cable-laying platform positioned alongside so that the center of the cable bay was in line with the level wind fairlead of the CLAMM.

The decking of Pier 2 was about 15 feet above the mean waterline during the cable loading period. The top of the CLAMM reel core, and the bottom roller of the level wind fairlead, were about 7 feet above the pier deck and thus about 13 feet above the deck of the YC-1092 when loading commenced. The cross-deck steel frame had not been installed prior to the cable-loading operations

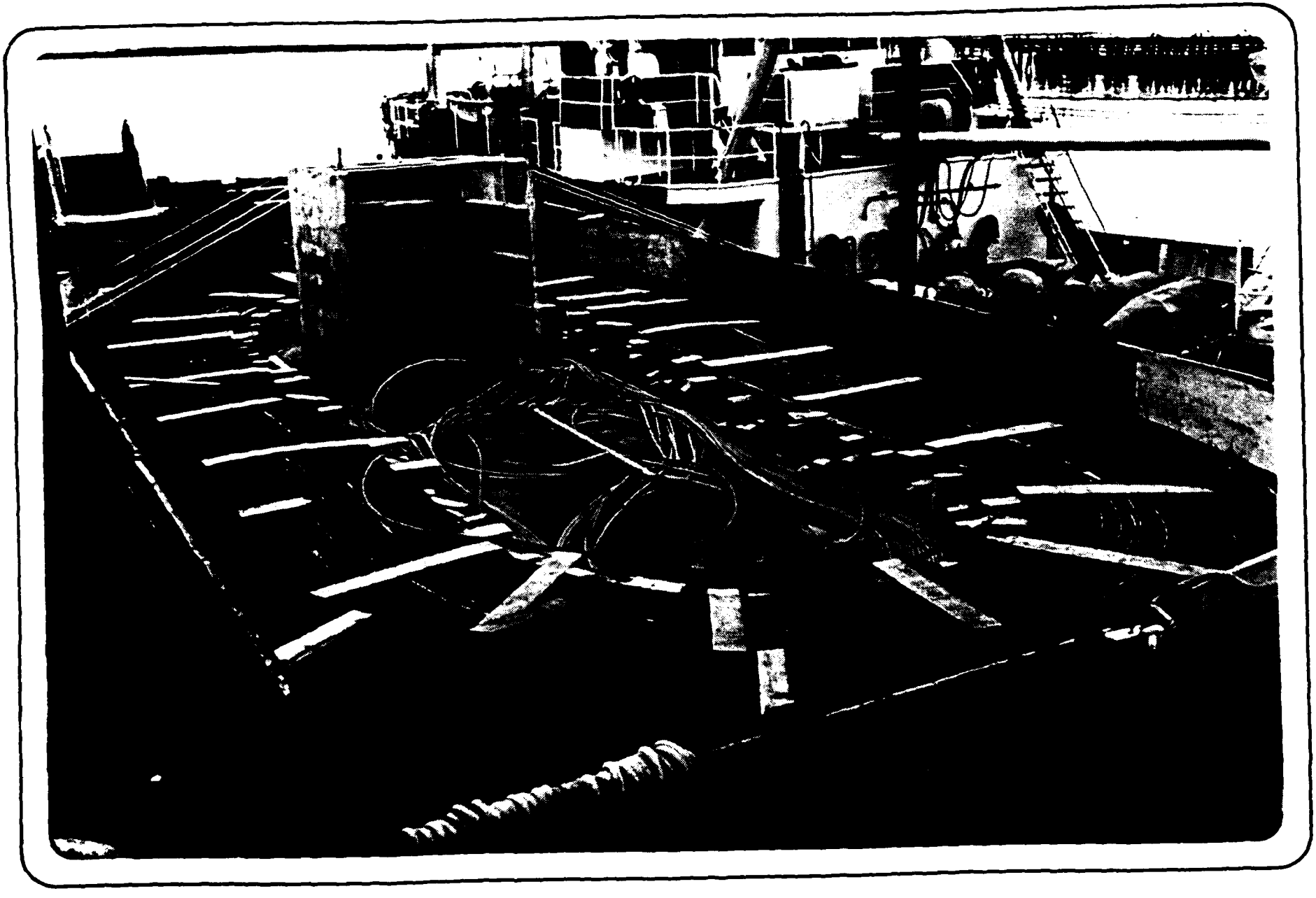
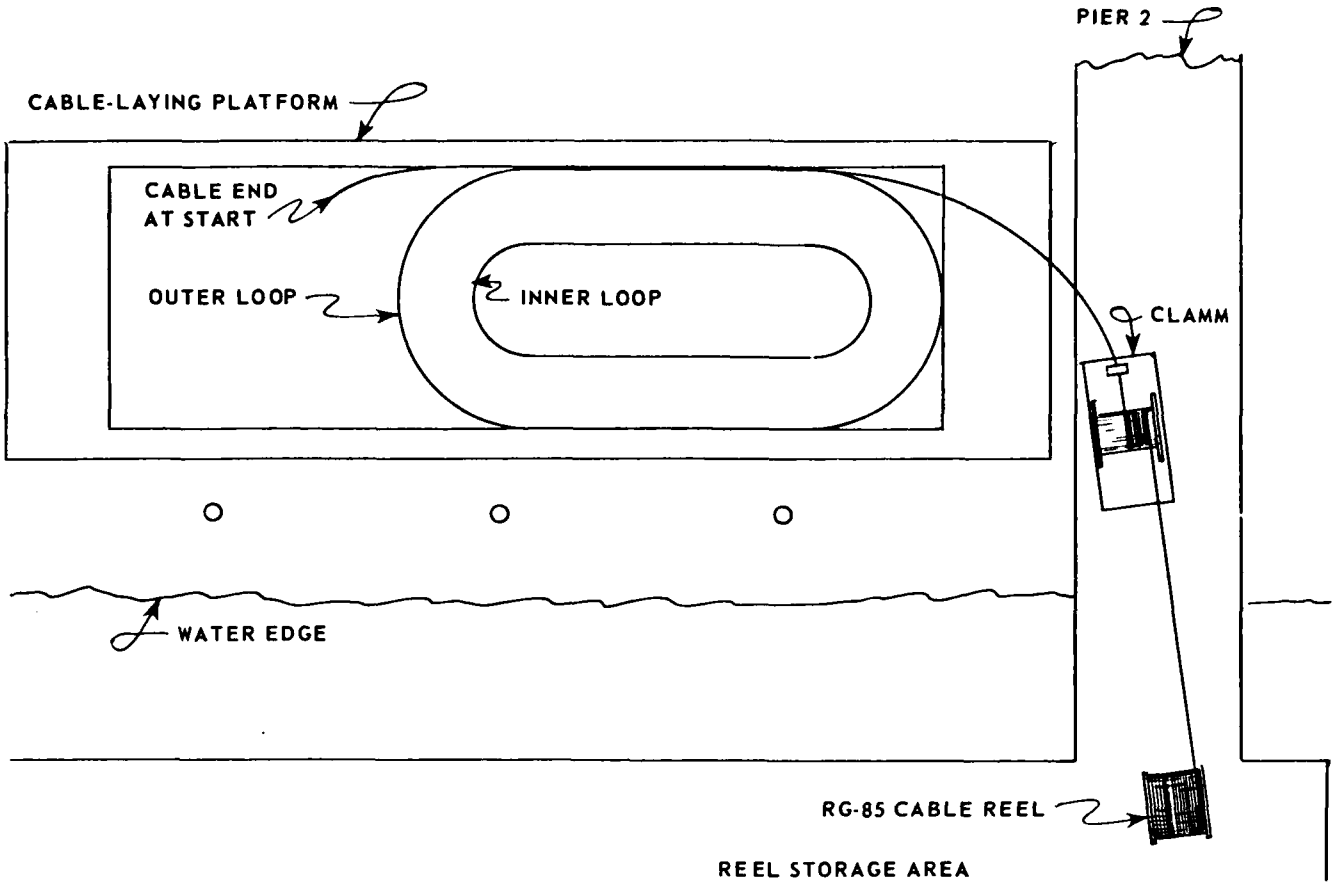


FIGURE 15: CURVED PLYWOOD BULWARKS FITTED AROUND THE CABLE BIN ON THE YC-1092



SKETCH OF CABLE LOADING ARRANGEMENT
FIGURE 16

and therefore the CLAMM could be controlled to feed the cable down to the deck where it was hand fed into place in the cable bay. This general loading arrangement is sketched in Figure 16.

It had been planned to load first the cable for Destruction Island and Smith Island. This totalled some 80,494 feet of RG-85 surplus communications cable carried on 35 reels. The procedure was to load each layer in the cable bin starting with the outside loop and working inward toward the center loop. The first loop started with a 10-foot length of cable leading aft outside the loop so that the end was free for the electrical checkout procedures required as the stowage progressed.

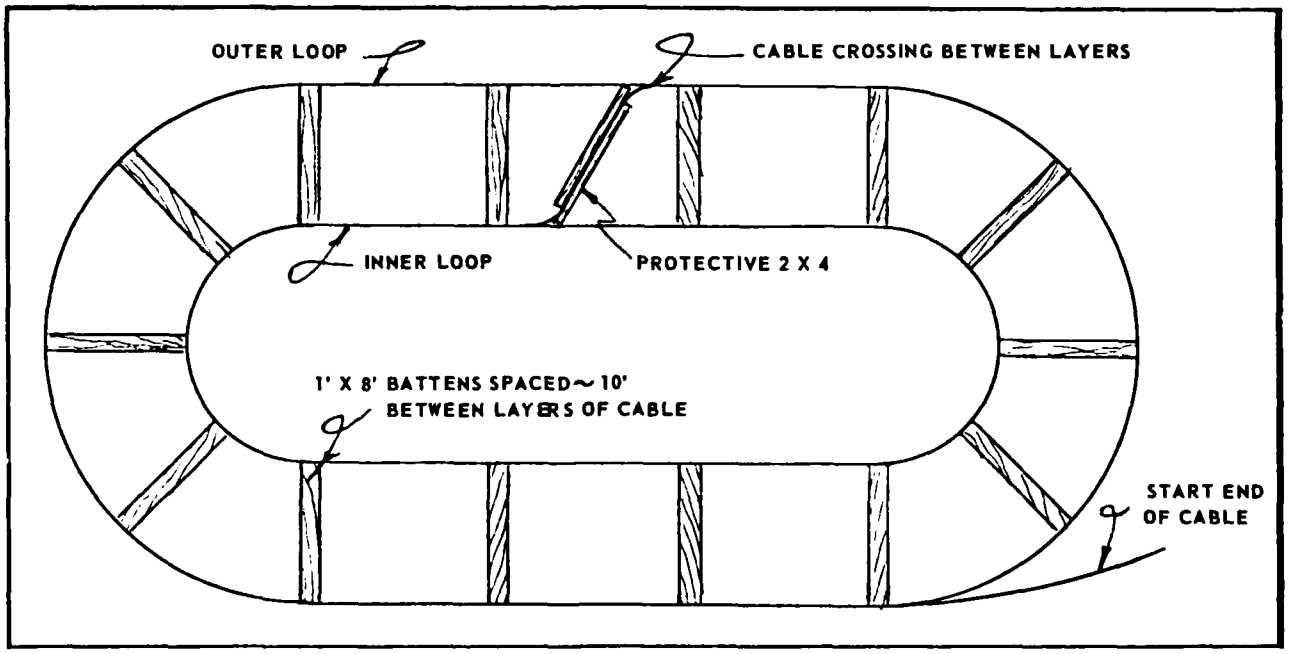
These electrical tests were conducted by telephone technicians from the 13th Coast Guard District using standard volt-ohm meters, fault locating equipment, and Meggers. Each test comprised checking across the free ends of the cable for electrical continuity, and Megger readings taken to determine insulation resistance. Accurate records of all tests were kept with sufficient identification data to locate along the cable the quality of the cable and the splices. As a minimum, checks were made at the following steps in the loading process:

- o Each reel of cable was checked prior to splicing and prior to unreeling.
- o After each splice was made the entire length of previously spliced cable was checked before unreeling the last reel.
- o After unreeling each reel and stowing aboard prior to making the next splice.

Any reel that did not satisfactorily meet the first test above was not spliced in but was set aside. The cable splices were performed in conformance with the instructions provided by Mr. Duc Trinh of the Hexcel Corporation after his arrival in Astoria on 8 September 1976. These instructions are summarized in Appendix C.

Splicing and loading commenced on 9 September 1976 with Coast Guard telephone technicians working fourteen hour days, seven days a week. Starting with the first reel of communications cable, the first layer was put down starting with the outer loop and working inward. As the end of the first reel was reached, the prescribed electrical checks were made, the next reel spliced on the end, electrically checked again, and the laying continued. These checks were repeated as each reel was spliced in and stowed.

Approximately two reels were required per layer of communications cable in the cable bin. When the inside (48th) loop of the first layer was in place, the cable was run radially outward over the top of the first layer to start the first loop of the second layer around the outer edge of the cable bin. As shown in Figure 17, this crossover section of the cable was protected from the weight



SKETCH OF CABLE CROSSING BETWEEN LAYERS

FIGURE 17

of succeeding layers by fitting 2 x 4 inch lumber on either side of the crossover. In addition, the 1 x 8 foot sheets of 1/2 inch plywood were laid down about every 10 feet over the layer before the next layer was started. This process was continued until the 14 layers of communications cable had been loaded aboard, Figure 18. The locations of the cable crossovers and the plywood battens were staggered between the various layers to keep the level of each layer as even as possible. By 28 September 1976, all of the RG-85 surplus communications cable required for the operation had been loaded aboard the YC-1092. Lengths between splices of stowed cable are given in Appendix C.

It had been planned that the loading of the ITT power cable would proceed in the same manner described above except that the cable would be supplied initially on three reels and only two splices would be required if there was no electrical discontinuity. As shown in Figure 16, the ITT power cable stowage was to start with an open end running along the inside of the port bulwark to provide access for electrical checks. The 7 1/2 layers of this cable were intended to be stowed in the same manner as the communications cable with the same type of crossover protection and the same batten protection between layers.

The ITT cable is of double-armored, torque-free construction. It handles and bends in a fairly docile manner -- until it is coiled on a reel; when uncoiled, and laid in a 125-foot circumference loop, the cable must untorque the equivalent of six or seven turns. Although the soft-armored RG-85 cable did this quite readily, the high tensile, double-armored ITT cable would only partially relax the torque built up during the coiled stowage and, as a result, would hockle after two or three turns around the bin. Despite several attempts at handling the cable in different ways, it refused to follow the planned bin storage contour.

As a first alternative, some 2000 feet of the ITT cable was laid in a figure eight configuration in the center of the cable bin inside the loops of the RG-85 cable with the location of the crossover points being varied to avoid a hump. However, this technique was abandoned as being too risky because of the potential of fouling the cable if some six miles of it were stowed in this manner. These inner loops are visible in Figure 18.

At this point a decision was made to reel the ITT cable on to the CLAMM drum, which held more than 16,000 feet of this 1.15-inch diameter cable, and to lay the Cape Flattery cable directly off the CLAMM. This meant that the

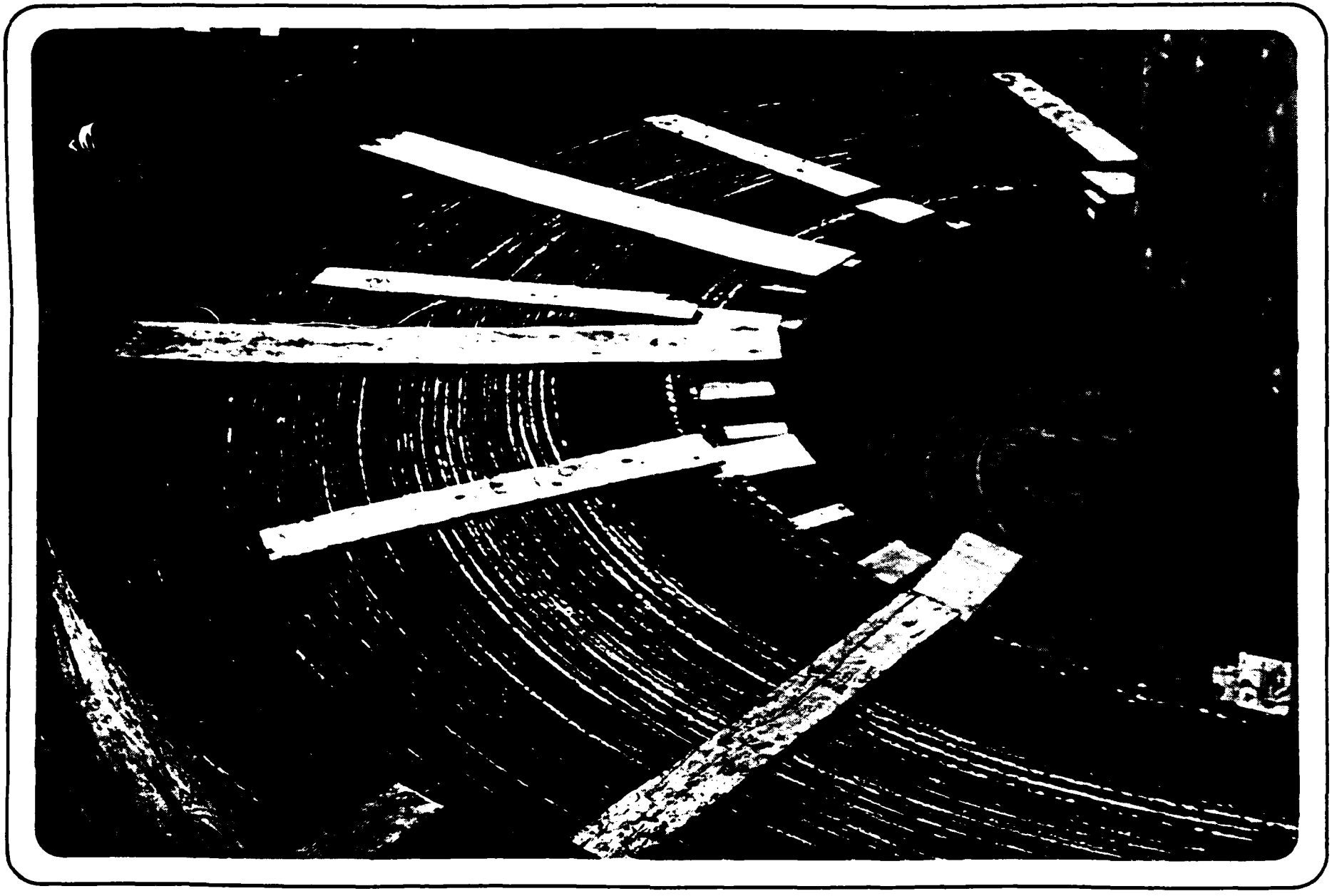
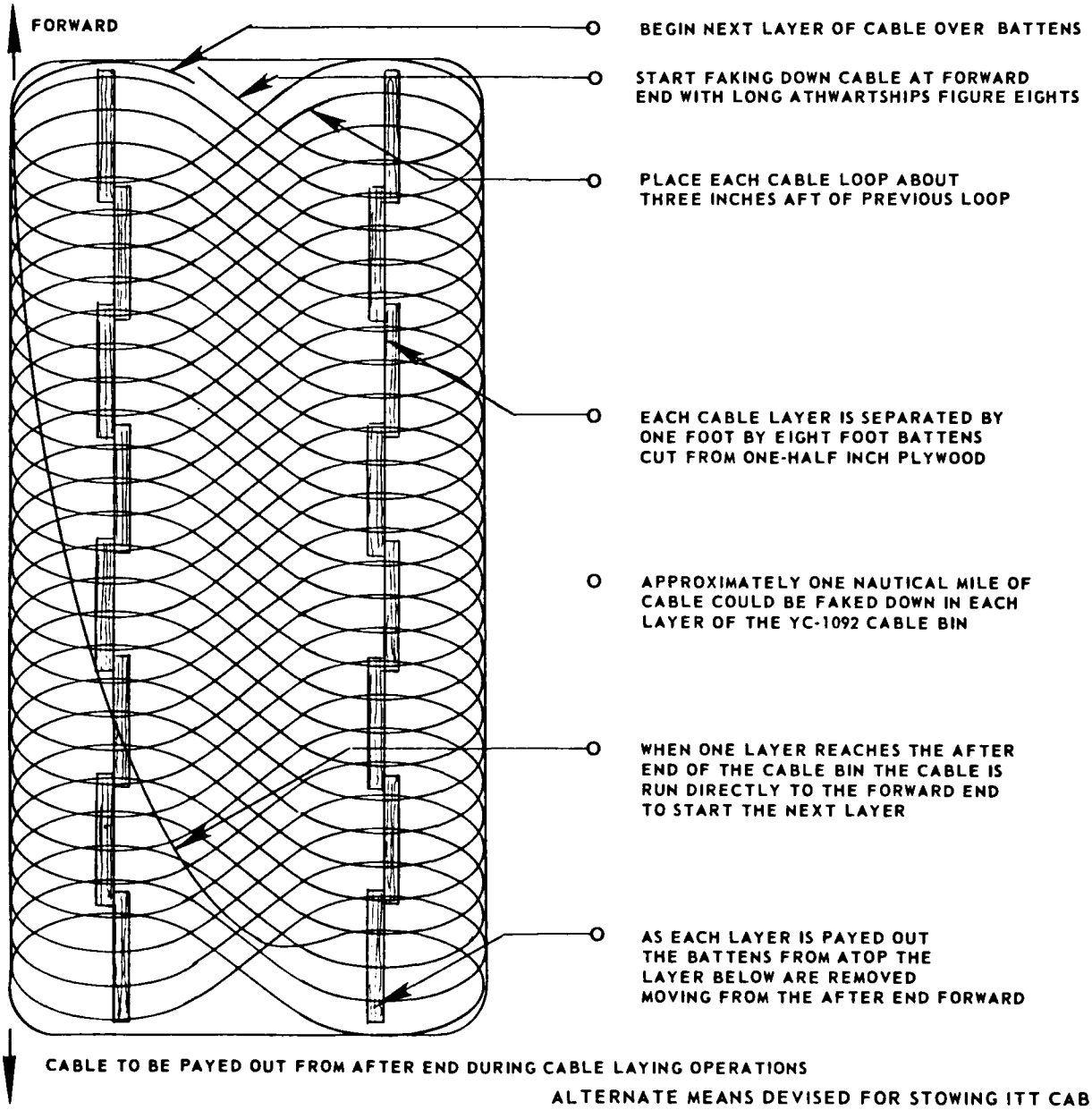


FIGURE 18: TOTAL LOAD OF RG-85 CABLE WITH INNER LOOPS OF ITT CABLE

two splices, between the three sections of cable, would have to be made aboard the cable-laying vessel rather than at the base in Astoria. Of the four original reels of ITT cable received in Astoria three were finally trucked to Neah



ALTERNATE MEANS DEVISED FOR STOWING ITT CABLE
FIGURE 19

Bay and there reloaded on the CLAMM drum. This machine, aboard the USC*GC WHITE BUSH*, was used for the Cape Flattery cable installation. An alternative means of stowing the ITT cable in the cable bin aboard the YC-1092, shown in Figure 19, was devised in the event that splicing at sea might prove infeasible. Although not used at Cape Flattery this might be considered for some future operation.

4.0 TOWING OPERATIONS AND FINAL PREPARATIONS FOR CABLE LAYING

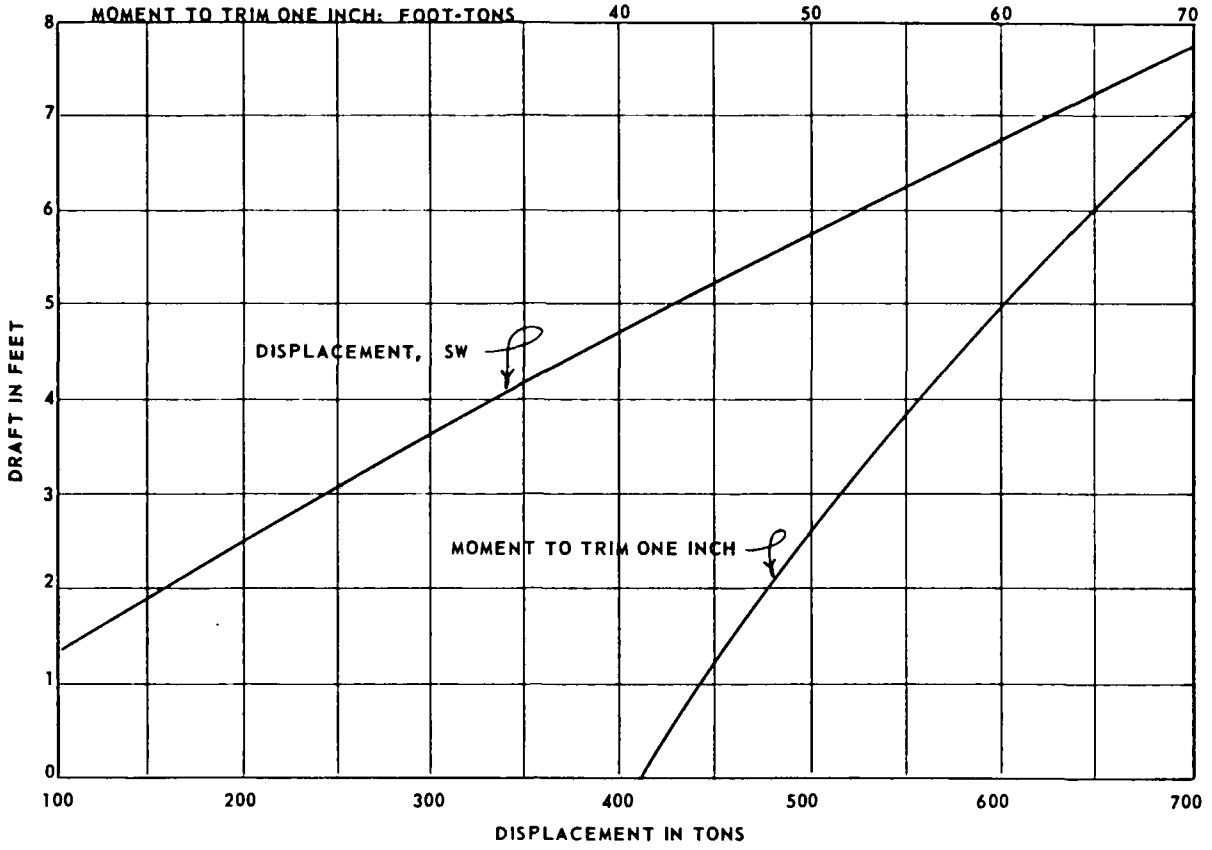
4.1 DISPLACEMENT AND TRIM OF THE CABLE-LAYING PLATFORM

The YC-1092 has a nominal carrying capacity of 500 tons and a light ship weight of 145 tons for a total loaded displacement of 645 long tons. As can be seen from the displacement curve of Figure 20 this gives a light ship draft in salt water of 1.83 feet and a loaded draft of 7.22 feet. When the YC-1092 was inspected in Seattle prior to acquiring it for this operation it had a draft of 2.00 feet, even keel, salt water. This indicates a displacement of 159 tons; although this is greater than the reported light ship weight, and may be due to some water in the tanks, this value was used as a basis for the modifications and cargo to be added for the LAMP project.

The weights added to the barge and their longitudinal centers of gravity are tabulated below along with the maximum deck loading that they incurred when placed aboard the YC-1092; these latter values are cumulative for those elements that are co-located.

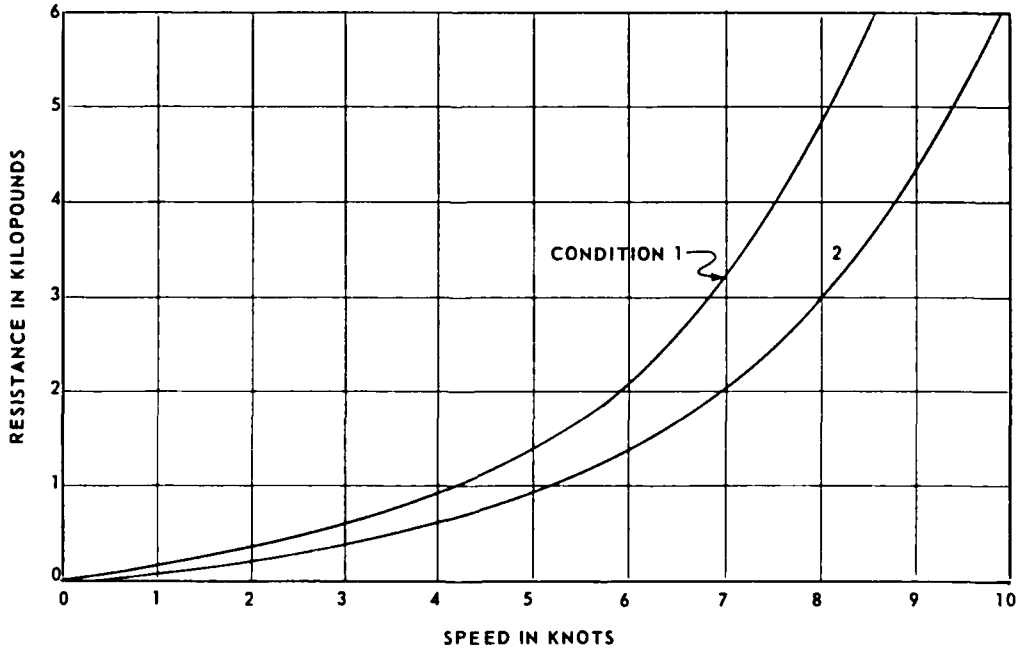
	WEIGHT#	LCG FROM FEET	LOAD IN #/FT^2
ITT CABLE 2,210 FEET	4,420	+ 15.00	↓
COMMUNICATIONS CABLE, 80,494 FEET	233,432	+ 15.00	↓
PROTECTION & SHORING LUMBER	4,000	+ 15.00	166.1
CABLE TRANSPORTER (CLAMM)	9,000	- 33.60	70.3
CABLE TENSIONER	2,000	- 33.00	34.7
CABLE FAIRLEAD STRUCTURE	2,000	+ 15.00	400.0
MISCELLANEOUS GEAR & ANCHORS	12,000	- 36.00	210.9
TOTALS	266,852#	@ 10.71 FT. FWD.	
OR	119.13 TONS	@ 10.71 FT. FWD.	
LIGHT SHIP	159.00 TONS	@ 0 FT. FWD.	
TOTAL	278.13 TONS	@ 4.59 FT. FWD.	

From Figure 20, the mean draft at this displacement is 3.45 feet and the corresponding moment to trim one inch is 53.0 foot tons. The forward trimming moment is 1277 foot tons giving a trim of 24.09 inches or 2.01 feet. This gives a draft forward of 4.45 feet and a draft aft of 2.44 feet. The actual drafts varied somewhat from these estimates since some of the listed equipment was not yet installed. During the tow from Astoria to Port Angeles the draft forward was 3.83 feet and the draft aft was 2.67 feet. Due to the trim by the bow created by this loading arrangement, it was most efficient to



DISPLACEMENT AND OTHER CURVES FOR YC-1092

FIGURE 20



RESISTANCE OF YC-1092 IN VARIOUS LOADING CONDITIONS

FIGURE 21

tow the platform astern during transit between Astoria and Port Angeles and between Whidbey Island and Neah Bay; this improved the dynamic stability of route of the towed system.

The deck loading capacity of the YC-1092 can be assumed to have a minimum value of its 500 tons cargo carrying capacity distributed over the 2464 square feet within the bulwarks. This gives a loading capacity of 455 pounds per square foot. Designs of this type are usually capable of supporting at least 500 pounds per square foot and therefore the maximum load concentration listed in the table above is within acceptable limits.

The loading condition and the corresponding displacement, draft, and trim upon departing Astoria can be designated as Condition 1. The displacement and trim of the cable-laying platform changed during the operation as the cable and consumable equipment was off-loaded. Assuming total usage of the materials allocated to each site, Condition 2 obtained after the Smith Island installation:

Displacement 232.10 tons,	Draft, forward	3.42'
	Draft, aft	2.29'
	Draft, mean	2.85'

The YC-1092 was towed by the stern for all transit operations. A trim by the stern is desirable to provide dynamic stability of route in towing but the actual resistance, or towrope pull, required will be roughly the same for either ahead or astern towing. Thus the resistance curves given in Figure 21 for the YC-1092 are applicable to either the transit mode or the cable-laying mode for each of the two loading conditions cited above.

4.2 TRIAL RUNS IN THE COLUMBIA RIVER

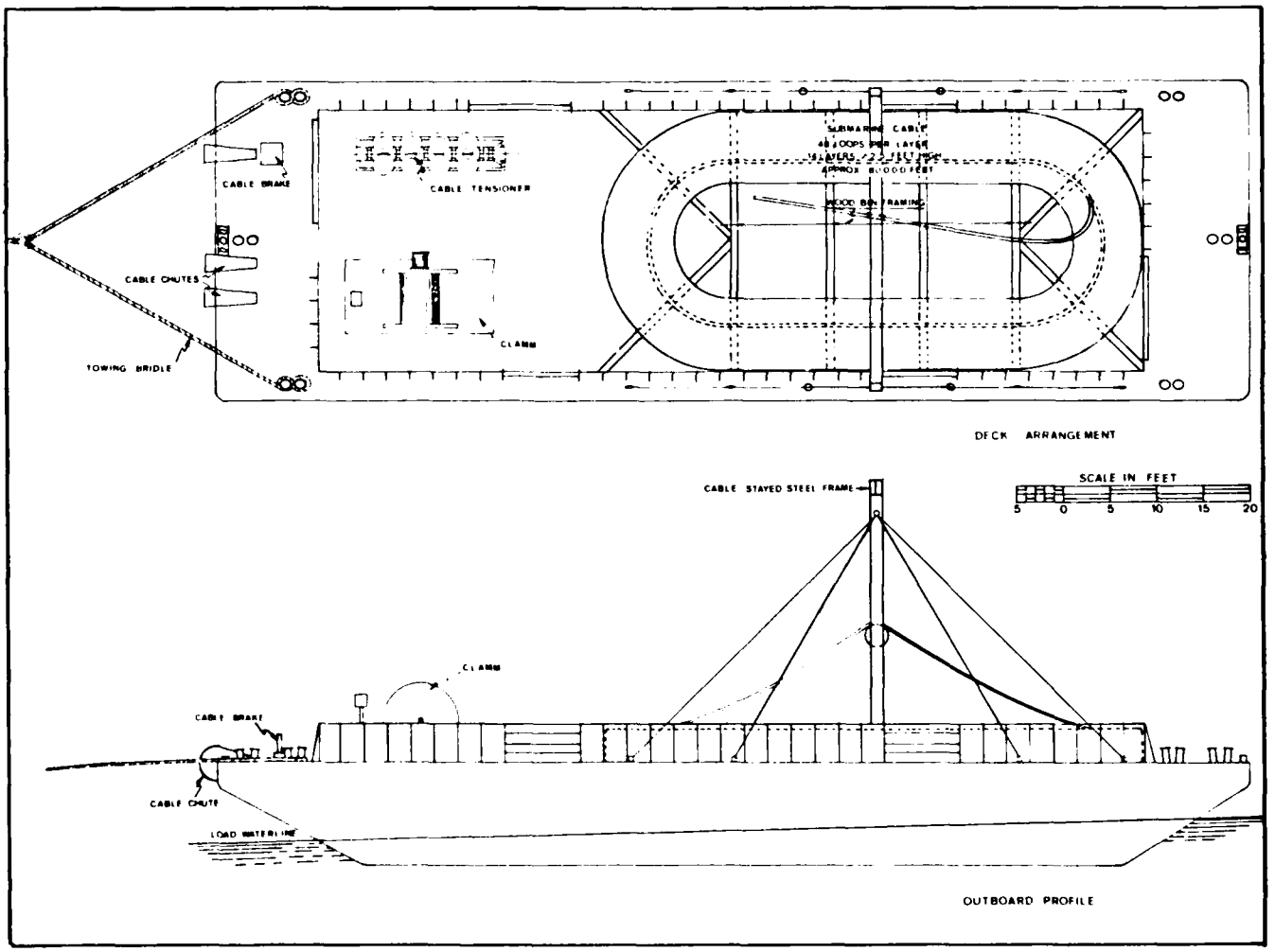
One day prior to the departure from Astoria, Oregon it was planned to conduct a shake-down devoted to training personnel and testing cable-laying techniques and equipment. These trials were to be conducted in the Columbia River off the U. S. Coast Guard Base, Astoria, Oregon. These trial runs had to be dispensed with for a number of reasons:

- Rough weather conditions in the Columbia River near departure time.
- The cable-laying schedule had already been delayed by other factors beyond the control of the project team.

- The Buoy Tender *WHITE BUSH* was much more efficient as a work platform than the *POINT COUNTESS*, previously intended as the towing vessel, so that it was possible to familiarize the *WHITE BUSH* crew with handling the YC-1092 during the transit to Port Angeles.

4.3 TOWING FROM ASTORIA TO PORT ANGELES

The *WHITE BUSH* took the YC-1092 in tow from the U. S. Coast Guard Station at Astoria, Oregon on 5 October 1976. The cable-laying platform was towed stern-first, using the bridle arrangement shown in Figue 22. The trip was made in six foot swells topped by a two foot wind chop. A 450 foot length of 6" nylon towing hawser was used and the trip was made at an average speed of 7.5 knots, without incident and the tow was docked at Port Angeles.



YC-1092 ARRANGED FOR TOW TO PORT ANGELES

FIGURE 22

4.4 NAVIGATION EQUIPMENT AND PROCEDURES USED IN CABLE-LAYING

The following navigation equipment was to be used for cable-laying operations:

- Motorola Mini-Ranger console with 3 transponders, 3 tripods for the transponders, 24-volt batteries to supply direct current to the console and transponders, and electrical cables for all units.
- Three transits, with tripods
- Portable depth recording system
- Miscellaneous navigation tools and supplies
- Navigation charts
- Eight 12-volt batteries, with 2 battery chargers

This equipment was shipped directly to the Port Angeles Air Station dock and put aboard the appropriate vessels at that point.

Navigation central for cable-laying operations was established on the *WHITE BUSH*. It included the Mini-Ranger console (receiver and readout) and the depth recording system. Depth recordings were made of both cable routes but it was necessary to use the *WHITE BUSH* depth measuring equipment since the portable gear was inoperative. It had been hoped that the portable depth recording system could be used in a small boat to record bottom conditions of the near-shore area during cable transfers while the barge was moored. The navigator aboard the *WHITE BUSH* received input from the shore-based stations and from the *WHITE BUSH* bridge, and maintained a continuous plot of barge location and over-the-bottom distance travelled.

The location and zero reference angle of all navigation shore stations for use of both the Mini-Ranger transponders and the surveyor's transits was to be determined prior to the day of cable installation, and verified again just before cable laying. The Mini-Ranger console and transponders, and the transits were to be transported to each site, as necessary, prior to installation to obtain this information. The information was used as a navigation input during cable laying and as a record of the installed cables, location of splices, etc.

Two "Navigation Format" sheets were prepared for use during the installations. Navigation Format #1, Figure 23, was to be used to record the precise location at each site of the Mini-Ranger transponders and the surveyor's transit as well as the zero angle reference used with the surveyor's transit at each site. Note that the location and angle reference data was, in most cases, "relative"

NAVIGATION FORMAT #1
FIGURE 23

LIGHTHOUSE _____ DATE ___
FROM _____ TO _____

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. _____ SITE NAME OR DESCRIPTION _____
MINI-RANGER TRANSPONDER CHANNEL (CODE) _____
TRANSIT ZERO ANGLE REFERENCE _____

SITE LOCATION DETERMINATIONS: _____

NAVIGATION FORMAT #2
FIGURE 24

LIGHTHOUSE _____ DATE ____
FROM _____ TO _____

TIME OF DAY	MINI-RANGER STATION READINGS RANGE IN METERS				TRANSIT ANGLE READINGS			DEPTH IN FEET	REMARKS (INCLUDE DISTANCE TRAVELLED IN FEET)
	SITE 1 CHAN ___	SITE 2 CHAN ___	SITE 3 CHAN ___	SITE 4 CHAN ___	SITE 1	SITE 2	SITE 3		

information based on the range or distance to a known charted location. In certain instances the location or angle reference coincided with actual charted landmarks or true (or magnetic) bearing angles. If charted reference landmarks were not available, a detail description of the landmark, and the methods used in locating the site relative to the landmark, were recorded.

Navigation Format #2, Figure 24, provided for recording data obtained during the operation. The data, lighthouse reference, and time of day was recorded on all sheets. In addition to other reference uses, the time of day for each reading was the basic reference for coordinating this information with other project data, including the depth sounding chart recording. Mini-Ranger station readings register in meters; these were converted as required to feet of cable laid along the route. This appeared in the remarks column noting actual distance in feet travelled on the route, including doglegs, and not necessarily the distance in feet from a particular station. Transit angle readings were utilized to keep the barge on a straight heading or course and/or for navigation in the event of a Mini-Ranger system failure.

4.5 ADDITIONAL PREPARATIONS FOR CABLE-LAYING

All available background data were assembled for use of the project team during the forthcoming cable-laying operations. These included data on weather, tide, and current conditions at the installation sites; these are given here in Appendix E. Also, since there was no available means of measuring cable tension during the laying operations, the only way of controlling cable tension was to compare the cable entry angle into the water with calculated catenary curves of cables of comparable weights; these calculation results are given here in Appendix F. A final check was also made during the Port Angeles stopover to ensure that all of the miscellaneous equipment required for the operation was on hand. This list is given, along with the Permits, in Appendix G.

5.0 SMITH ISLAND INSTALLATION

5.1 RESCHEDULING OF CABLE-LAYING OPERATIONS

The installation plan as presented in the Project Execution Plan had been to splice and load approximately 80,000 feet of RG-85 surplus communications cable in the cable bin of the YC-1092 while at Astoria, Oregon, and then to

load approximately 40,000 feet of ITT cable, in a similar manner, on top. The cable-laying sequence would then have been first to lay the Cape Flattery Lighthouse cable (Tatoosh Island to Neah Bay). Since the operation would be staged at the Coast Guard Station, Neah Bay, it was then planned, if the weather and sea conditions permitted, to install the Destruction Island cable. The Smith Island to Whidbey Island cable was to be the last one laid. These plans were changed due to the following:

- Coiling difficulties with the ITT cable
- A decision to lay the ITT cable from the CLAMM with two at-sea splices with the result that the RG-85 cable would now not be covered by the ITT cable thus providing the option of laying either site first.
- A decision to defer the Destruction Island cable installation because of State of Washington permit delays.
- Inclement weather and sea conditions at Tatoosh Island (Cape Flattery).

Therefore it was decided that the Smith Island to Whidbey Island cable for the Smith Island Lighthouse would be the first to be installed.

5.2 STAGING FOR THE SMITH ISLAND OPERATION

The *WHITE BUSH* with YC-1092 in tow arrived in Port Angeles, Washington from Astoria, Oregon with all RG-85 cable and necessary equipment in readiness, with the exception of the cable tensioner. The tensioner was trucked from Seattle, where Jacobson Brothers Towing Company refurbished and revised it, to Port Angeles, where it was installed on the barge on 7 October 1976. Additional revisions, comprising cable roller supports between each set of tires, were made on the tensioner during installation, testing, and check-out, by the UCT-2 Seabees.

All staging for the Smith Island Installation was performed at Port Angeles, Washington, the home port of the *WHITE BUSH*. Two days prior to the installation, a contingent of Seabees drove the *LARC* and other equipment to Whidbey Island for shore preparation and for launching of the *LARC*.

5.3 SITE DETAILS, CABLE ROUTE, AND NAVIGATION AIDS

The Smith Island cable route was to be a straight run from Smith Island almost due east to Whidbey Island as shown in Figure 25.

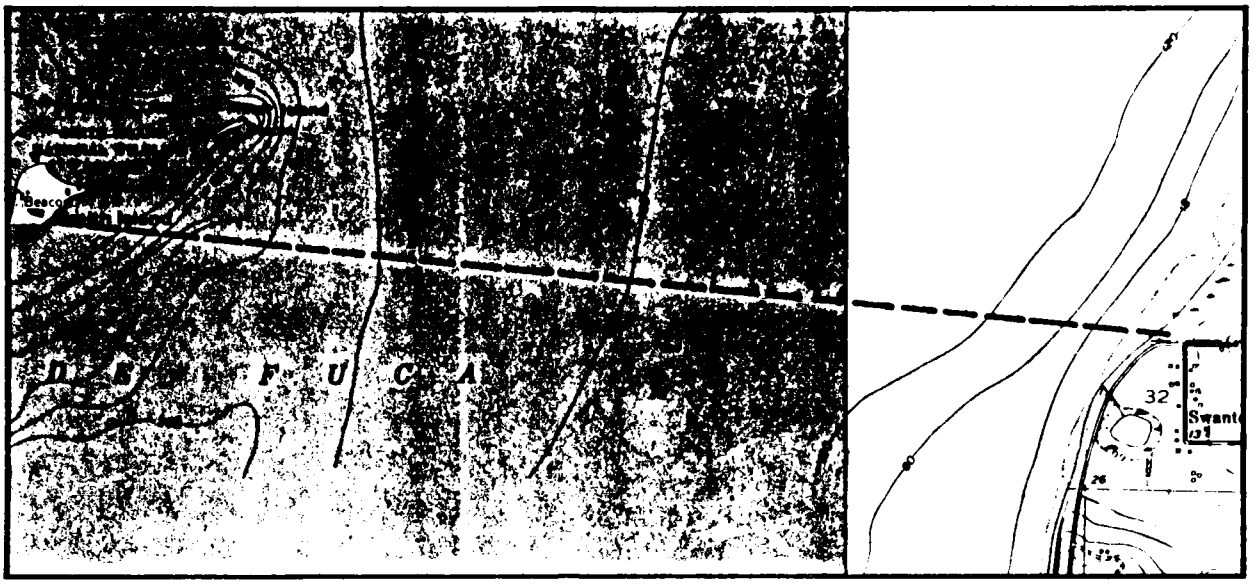


CHART OF SMITH ISLAND CABLE ROUTE

FIGURE 25

The survey report for this route was as follows:

- Whidbey Island Beach Site - An all sand bottom exists from mean low water on the beach to a 60 foot depth about 1,000 yards off the beach, with only small scattered rocks visible. A 50' strip of small loose rocks (up to 6" diameter) runs along the beach from the mean low water line up the beach, changing gradually to all sand. The Whidbey Island site is at the southeastern tip of the original Ault Field/Naval Air Station property. Appendixes A and B identify and locate the property more accurately. The beach is strewn with some rocks, debris, and a considerable number of logs of all sizes (some 3' in diameter and 60' long). Similar debris is found on all six beach landings for these three cable installations.
- Deep Water - Soundings indicate a gradual smooth bottom as deep as 250' on the run between Whidbey Island and Smith Island with sand and mud prevailing.
- Smith Island - About 350 yards southwest from the start of the land bridge (during low water) to Minor Island, a slight cove is formed covered with smooth, loose rocks considerably smaller in size than those in the surrounding area. This site is almost on a direct line from Smith Island Lighthouse to the beach site at Whidbey Island.

The rocks on the beach form a 50' wide path turning to sand higher up the beach. The underwater route is hard-packed sand gradually sloping to 30' depth then sloping steeper to 60', approximately 1,500 yards off the beach.

5.4 SMITH ISLAND CABLE LAYING OPERATIONS

On Friday, 8 October 1976, the USCGC *WHITE BUSH* (WLM-542) installed two buoyed clump moors at the cable approach to Smith Island and two at Whidbey Island. They then proceeded to perform practice navigation and familiarization runs between Smith Island and Whidbey Island.

At 0600 on Saturday, 9 October 1976, the *WHITE BUSH* arrived at Smith Island with the cable barge alongside ready to install cable, Figure 26. Dense fog and zero visibility delayed preparation, mooring, and coordination with other units for several hours. The UCT-2 *LARC* was escorted from Whidbey Island to Smith Island by the *WHITE BUSH* and, by 1100, the *WHITE BUSH* was moored off Smith Island ready to float the bitter end of the cable ashore.

The bitter end of the cable was passed to the *LARC* for hauling ashore. The Seabees attached balloon type salvage floats (300 lb. buoyancy) to the cable every 50 to 75 feet, Figure 27. At this time the fog was intermittent enabling visual sighting of Smith Island. As back-up the *WHITE BUSH* radar continuously tracked the *LARC* while maintaining radio contact.

Once on the beach, the *LARC*, Figure 28, hauled 500 feet of excess cable ashore for use in running the cable up to the terminal building near the lighthouse. (Note that an additional 600 foot length was flown by helicopter from the cable barge at Port Angeles to Smith Island a few days later to provide the additional cable required to reach the lighthouse. By landing this cable at the helicopter pad near the terminal building the cable was then hauled downhill to the end of the installed cable.) The float balloons were cut off the cable by UCT-2 Seabee divers accompanied by a Seabee inflatable *ZODIAC* craft. The cable settled to the bottom.

At 1249 the *WHITE BUSH*, with the cable barge alongside, commenced laying cable. The tensioner was extremely effective in its operation permitting cable payout at an average rate of 3 knots, Figure 29. The holdback force on the cable by the cable tensioner was estimated at about 500 pounds. The *WHITE BUSH* slowed as each of thirteen cable splices passed through the tensioner. Some

FIGURE 26: YC-1092 SECURED ALONGSIDE THE WHITE BUSH FOR CABLE LAYING

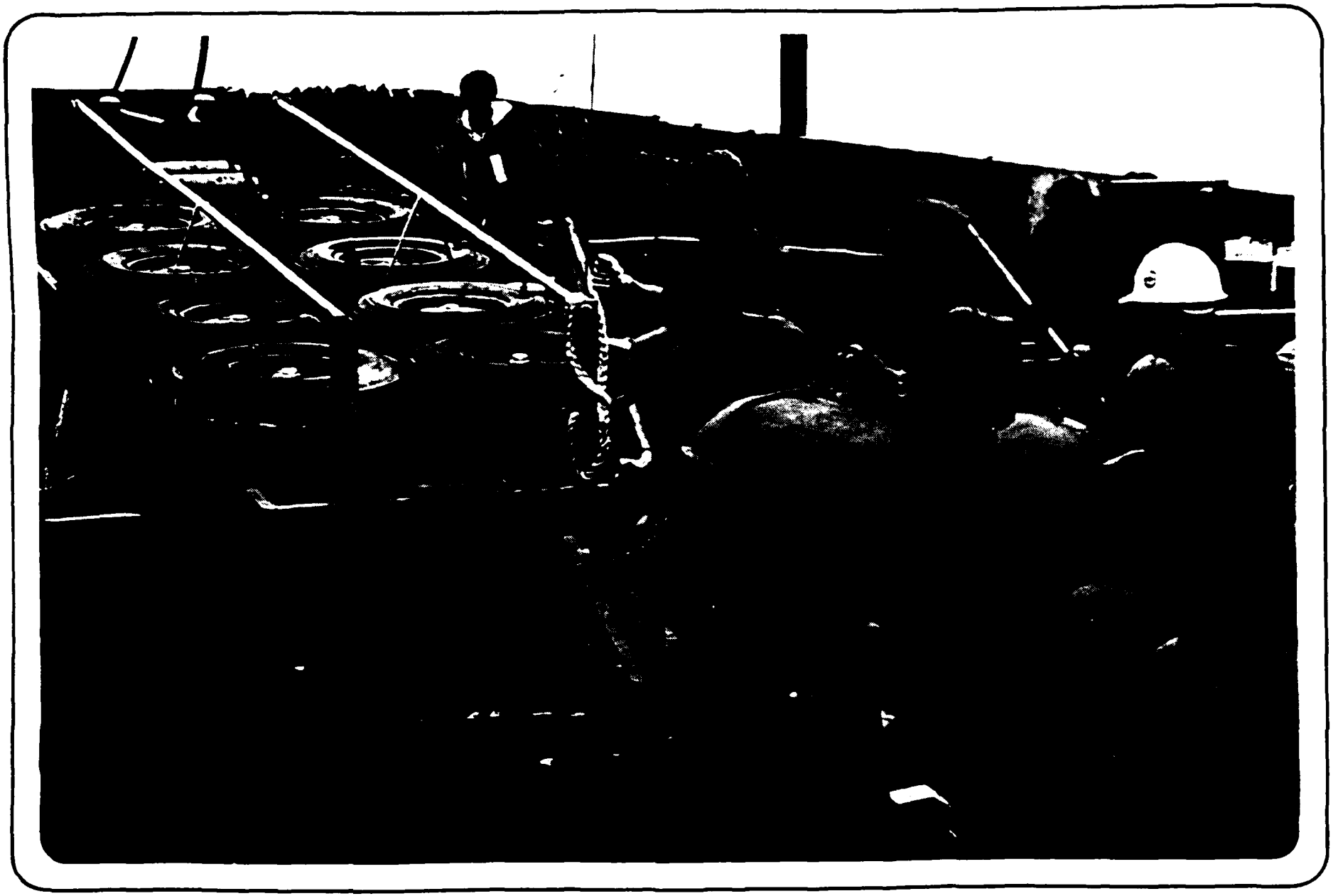


FIGURE 27: SEABEES ATTACHING FLOATS TO THE RG-85 CABLE PRIOR TO FLOATING ASHORE

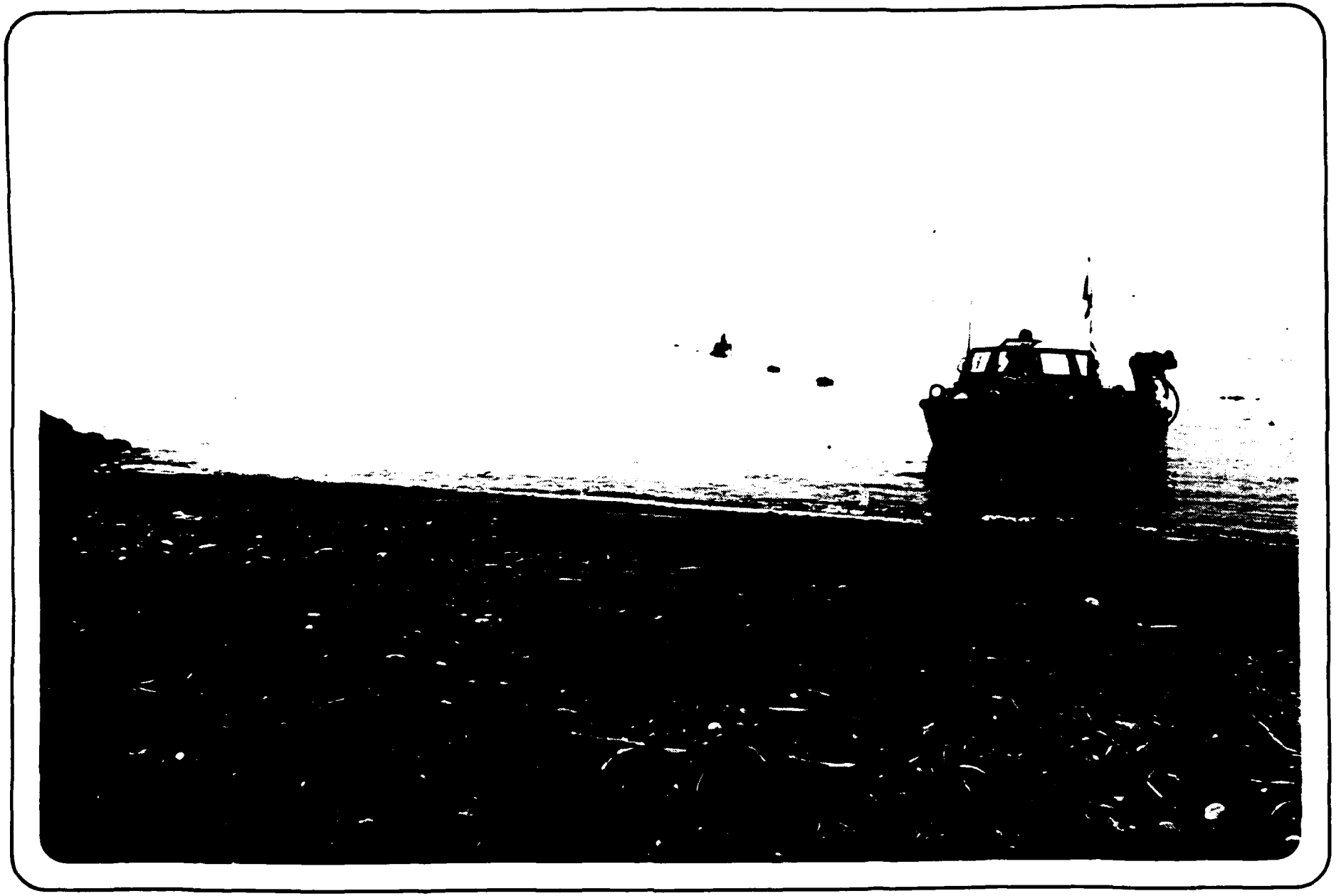


FIGURE 29: LAYING CABLE OFF THE STERN OF THE YC-1092

slack cable was dropped as the splices passed overboard so that no excessive strain would be placed on these critical elements of the cable. The fourteenth splice was put out while moored off Whidbey Island.

The fog prevented sighting the mooring buoys during the approach to Whidbey Island. As a result, the cable track, detailed in Appendix H appears erratic just prior to mooring.

When moored near Whidbey Island, approximately 1,600 feet from the power pole on the beach, 2,100 feet of cable was floated off the barge and hauled ashore by the *LARC*. The beach trench had been prepared previously by the Seabees with the assistance of personnel and equipment from the U. S. Naval Air Station, Ault Field, Whidbey Island. Approximately 300 feet of excess cable was pulled ashore for use in the electrical hook-up. Due to current, fog, and *LARC* limitations, not all of the surface catenary was pulled out of the cable prior to cutting off the float balloons and releasing the cable. Fortunately, the soft sand bottom in this area permitted rapid sinking and burial of the cable. Underwater diver inspection, on Sunday, 10 October, revealed that the cable was already partially buried in the sand. Further underwater inspection of the cable showed nothing unusual except for a slight birdcaging of the cable armor over an eight inch section about 50 yards seaward of the mooring site. This was no doubt caused by excessive maneuvering during the dense fog immediately prior to mooring. Only the armor appeared affected, not the core of the cable. Electrical tests on the cable after installation were all satisfactory.

6.0 CAPE FLATTERY INSTALLATION

6.1 SITE DETAILS, CABLE ROUTE, AND NAVIGATIONAL AIDS

A section of the NOAA-NOS survey chart detailing the Cape Flattery area is given in Figure 30. The existing cable route to Tatoosh Island appeared to be satisfactory and therefore was utilized for the new power cable. A favorable approach to the lighthouse appeared to be into the protected sandy cove on the north side of Tatoosh Island, Figures 31 and 32. The cable run to northwest Neah Bay (western end of breakwater to Waadah Island) is about six nautical miles. A commercial power source (pole) is located a few feet from the cable landing beach site, at Neah Bay.

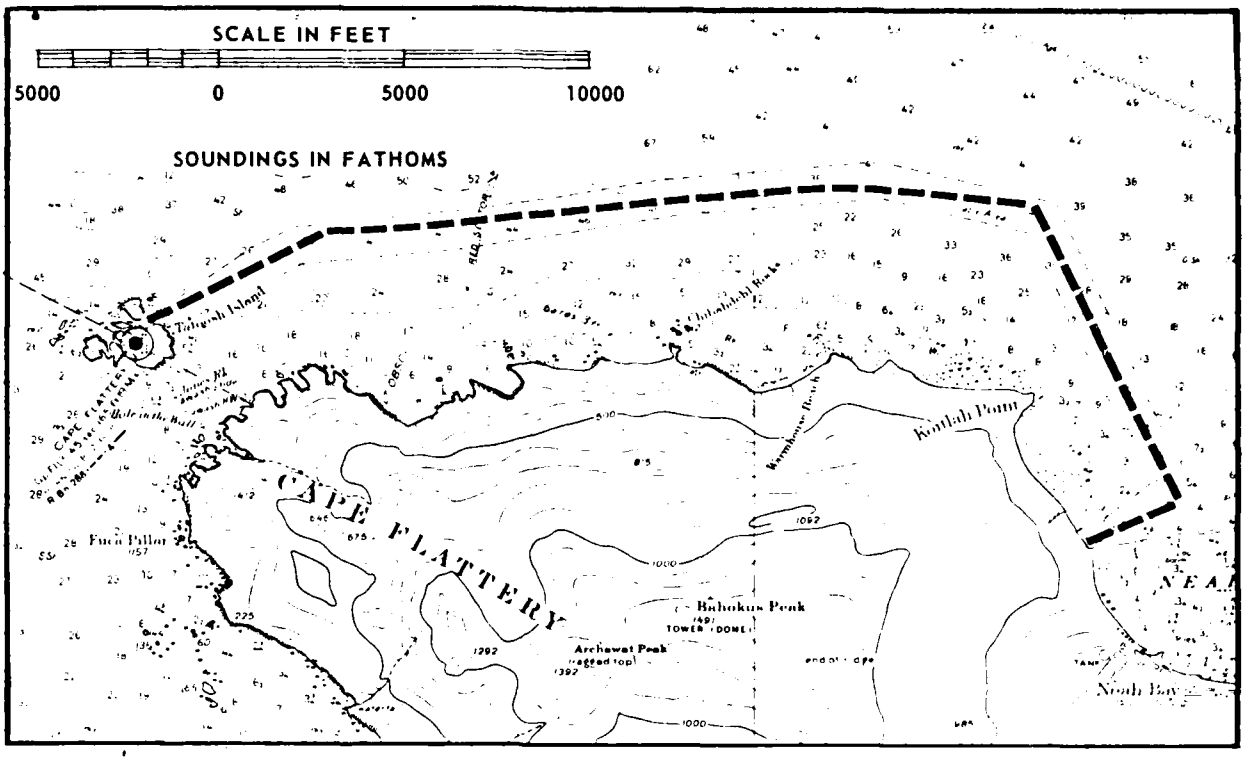


CHART OF CAPE FLATTERY CABLE ROUTE

FIGURE 30

Navigational aids, consisting of a Mini-Ranger transponder and a surveyor's transit were to be set up in the following locations:

- o Cape Flattery Lighthouse on Tatoosh Island;
- o Waadah Island Light;
- o USAF radar dome on Bahokus Peak;
- o At the northernmost of the two lights on Waadah Island (just off the right side of Figure 30);
- o At the Neah Bay terminus of the cable.

The NOAA-NOS survey chart of the cable run between Tatoosh Island and Neah Bay shows four legs (3 turns) on the route. On only the first leg was a transit utilized to "keep the barge on line" while the Mini-Ranger recorded the range.

UCT-2 Seabee divers reported bottom conditions approaching Tatoosh Island to be rocky, erratic, and partially hazardous to the cable:

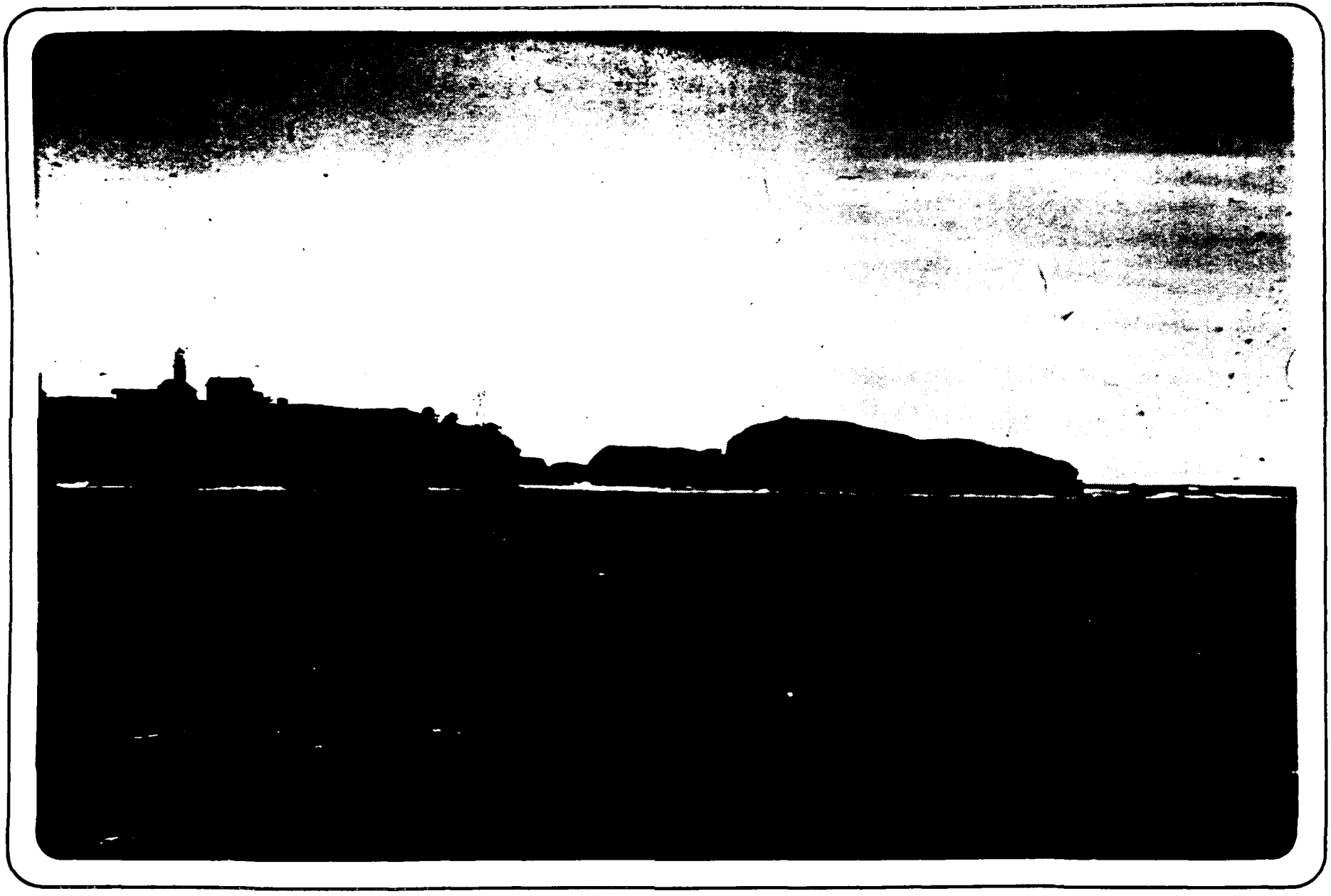


FIGURE 31: THE CAPE FLATTERY LIGHTHOUSE AND ADJOINING COVE

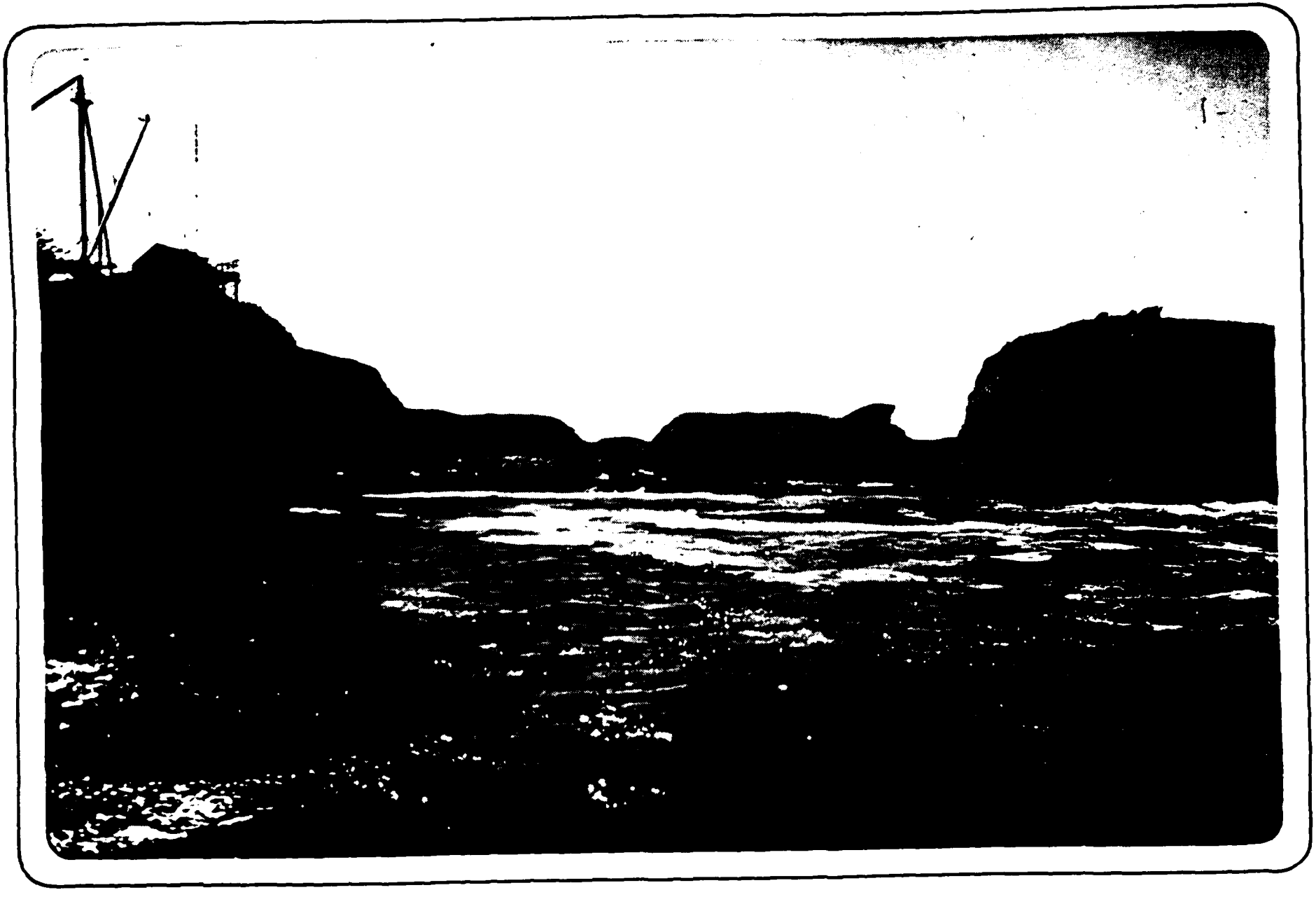


FIGURE 32: CABLE LANDING COVE ON TATOOSH ISLAND FOR THE CAPE FLATTERY LIGHTHOUSE

- o course sand out to 10' depth
- o 10' to 35' depth, heavy kelp
- o 20' depth, rocks 3' to 10' in diameter
- o gradual rocks and sand slope to 45' depth
- o at 38' depth rocks were 10' to 30' in diameter
- o crevices started at 38' depth
- o 45' depth, crevice 30' wide with sand bottom
- o 48' depth, ledge 10'
- o 55' depth, large crevice approximately 80' span about 35' to bottom
- o 65' depth, 3' ledge
- o 80' depth, vertical drop to about 100' depth
- o Beyond 100' depth the bottom is more graudal and smooth (reaching 300' maximum) into Neah Bay. Bottom conditions are rock and sand.

More detailed location and description information for the shore sites is obtained in Appendixes B and E.

It may be noted that the depth along the cable route averages about 25 fathoms (150 feet) for the first leg and 42 fathoms (252 feet) for the second leg. The third leg shoals off from 40 fathoms (240 feet) to 5 fathoms (30 feet), and the fourth leg runs from the latter depth up to the beach. Catenary data for the ITT cable, i.e., force and lead-off angles as functions of depth, can be obtained from the tables and curves given in Appendix F.

At the Neah Bay end of the cable route, UCT-2 divers have reported the following bottom conditions, working from the beach out to the east-northeast:

- o 0-15' depth, rock bottom with sandy areas; very heavy kelp with 2' diameter round rocks;
- o 15' to 30' depth, sand bottom with larger rocks; some small 2' rock ledges;
- o 30' to 45' depth, about 4/5 sand bottom with 2' to 3' rock ledges (with sharp edges); rocks up to 10' diameter;
- o 45' to 60' depth, smooth rock and sand, some rock boulders;
- o 80' depth is approximately 1,000 yards off beach landing site along cable route;
- o 12' depth at mean low water is about 300 yards from beach landing site.

6.2 STAGING FOR THE CAPE FLATTERY INSTALLATION

Upon completion of the Smith Island Cable Installation, the *WHITE BUSH* towed the YC-1092 to Port Angeles, and the Seabees, with the *LARC* and a truck load of equipment, mobilized there to prepare for the Cape Flattery installation. The *WHITE BUSH* towed the YC-1092 to the U. S. Coast Guard Station, Neah Bay, Washington. All project equipment and personnel were re-located to Neah Bay to stage for the Cape Flattery cable laying. Three reels of the ITT cable, originally trucked from San Diego to Astoria, Oregon, were then trucked from Astoria to Neah Bay.

Utilizing the twin boat-lifts at the Neah Bay Coast Guard Station, the reels of cable were first off-loaded from the trucks. Then, as needed before laying each leg of the Cape Flattery cable, the boat lifts transported the reels on rails to where the *WHITE BUSH* was moored at the end of the pier.

The CLAMM, which had been mounted on the YC-1092, was transferred to the buoy deck of the *WHITE BUSH* for the cable laying, Figure 33. The cable was reeled directly onto the CLAMM drum. New calculations were made which included that the CLAMM drum could hold each of the full reels of cable shipped from ITT, and that the CLAMM was sufficiently rugged to take the weight and laying forces of this cable.

6.3 CAPE FLATTERY CABLE LAYING

The *WHITE BUSH* got underway at 0730 on 14 October 1976 for Tatoosh Island. By 0945 the *WHITE BUSH* was moored between the two rocks off the cable-landing beach at Tatoosh Island. The *WHITE BUSH* was moored approximately 175 meters from the beach and 355 meters from the lighthouse, Figure 34.

The *LARC* hauled the cable, buoyed by balloon floats, to the beach. It then proceeded to haul bights of cable down the beach, thus providing 1,000 feet of excess cable. The 1,000' was more than enough to reach the cable power terminal building near the Cape Flattery Lighthouse.

A thirty foot high natural rock formation with a fifty foot circumference at sand level was used to secure the cable on the beach. Divers cut the floats off the cable progressively from the beach out toward the *WHITE BUSH*. The cable was inspected as it dropped to the bottom in an attempt to keep it in between rock formations and off potentially harmful rock ledges. Thick kelp and other marine growth interferred to some extent with this procedure.

FIGURE 33: THE USCGC WHITE BUSH RIGGED FOR THE CAPE FLATTERY OPERATION

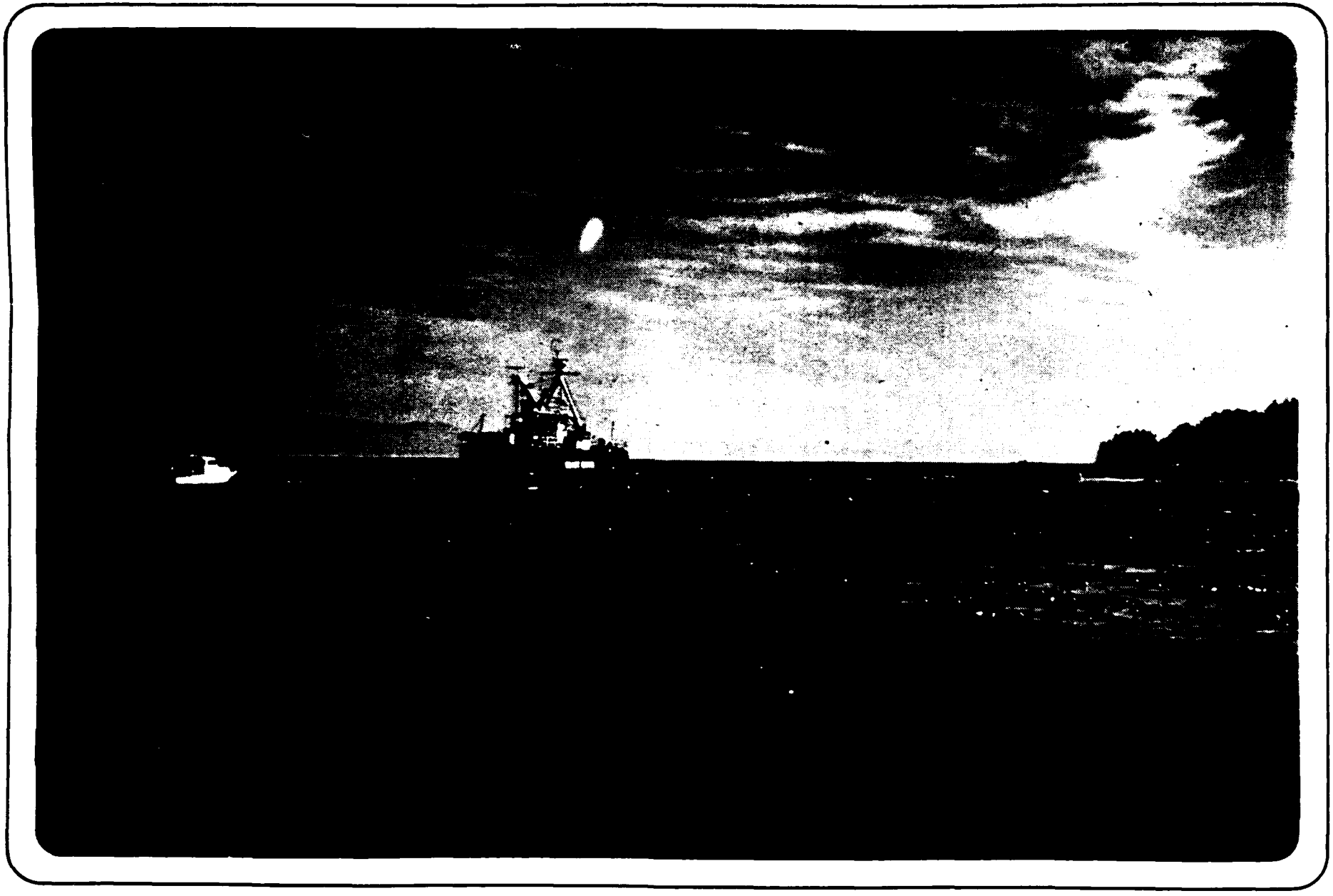


FIGURE 34: THE WHITE BUSH MOORED FOR RUNNING CABLE INTO TATOOSH ISLAND

With the floats removed and the *WHITE BUSH* out of the two point moor, cable laying commenced. Cable from the CLAMM had been fair-led from the buoy deck through a snatch block held by the boom off the starboard side of the *WHITE BUSH*, Figure 35. Cable laying proceeded smoothly at about 2 to 3 knots. Cable angle entry into the water averaged approximately 45°.

At completion of the run (the first of three between Tatoosh Island and Neah Bay), the cable end was passed to the Coast Guard *SAR* to hold until return of the *WHITE BUSH* with the second reel of cable.

By 2130 the same day, 14 October 1976, the *WHITE BUSH* had returned from the Coast Guard Station at Neah Bay with the second cable loaded on the CLAMM drum, and had retrieved the cable from the *SAR*. Splicing was completed at 0400 on 15 October 1976. By this time, weather conditions had deteriorated to the point where the armor splicing procedure had to be terminated early. As a substitute, a wire rope strap attached with wire rope clamps was used to stress-relieve the splice prior to continiuing laying the cable. A length of about 300 feet of excess cable was dropped at this location in 260 foot water depth to ensure freedom from tension at the splice.

After installation of this cable, both this splice and the second splice were re-done because of eventual electrical deficiences. The corrected splices proved satisfactory.

The second leg of the cable was laid in the same manner as the first and was buoyed off in relatively shallow water, approximately 90 feet deep, to await the laying of the third leg. The *WHITE BUSH* then returned to Neah Bay to load the CLAMM drum with the third reel of cable. Prior to laying this cable, the ship planted two chain-buoyed mooring clumps to moor to while the third leg of the cable was floated in to the beach.

The laying of the third leg of ITT cable started from the shoreline of Neah Bay. The *LARC*, Figure 36, hauled 300 feet of excess cable off the CLAMM drum on the *WHITE BUSH* up the beach for hook-up to the power pole. The *WHITE BUSH* then proceeded out to the buoy at the end of the second leg of cable that had been laid previously. The buoyed end of the second leg was hauled aboard and the second splice was made. This splicing was completed, and electrical continuity tests were performed by 0300 on 16 October 1976. The splice was then dropped overboard and the Cape Flattery cable laying ended. Details of the underwater cable route and splice locations are given in Appendix I.

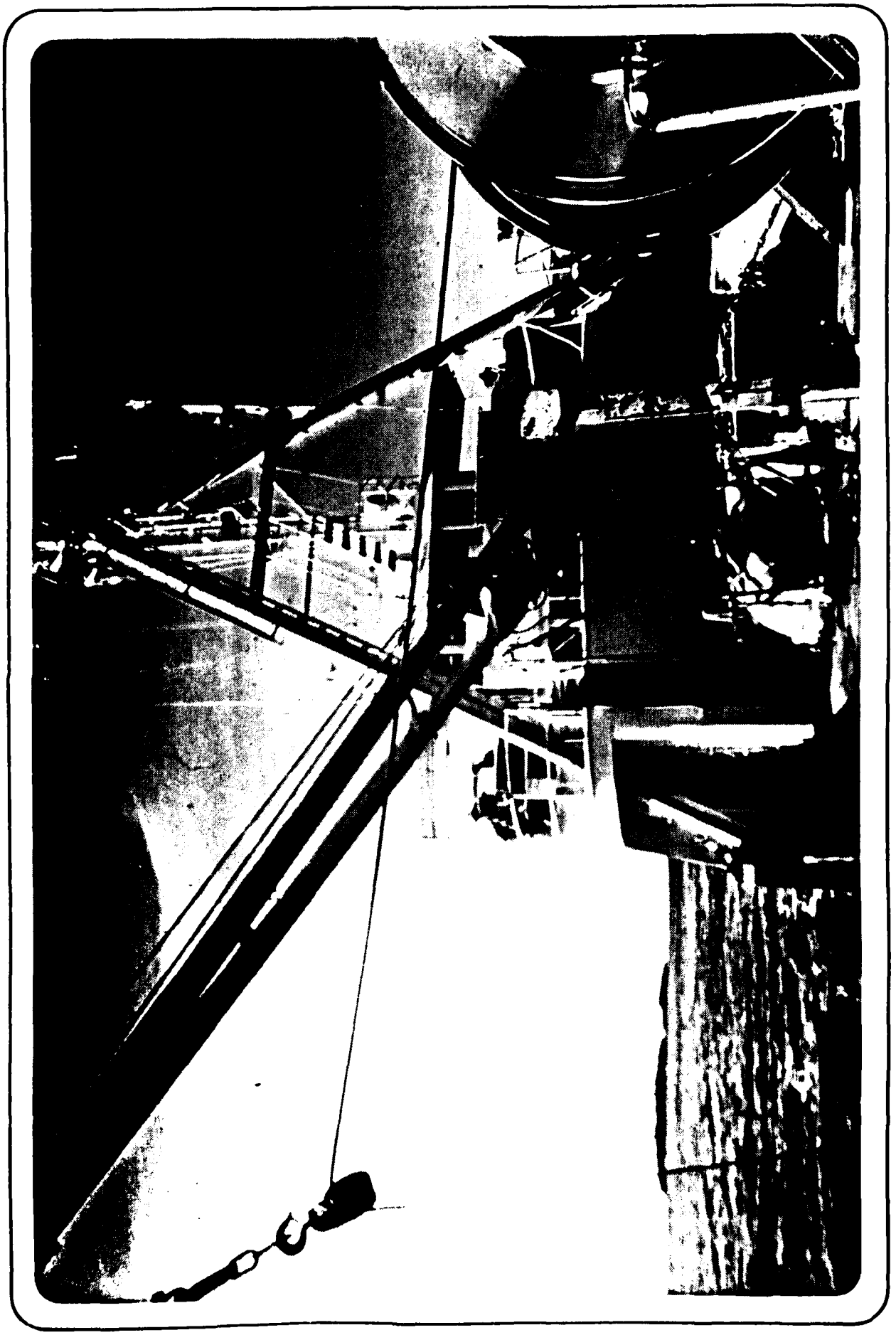


FIGURE 35: ITT CABLE LAID FROM CLAMM DRUM OVER SNATCH BLOCK SUSPENDED FROM BOOM OF WHITE BUSH

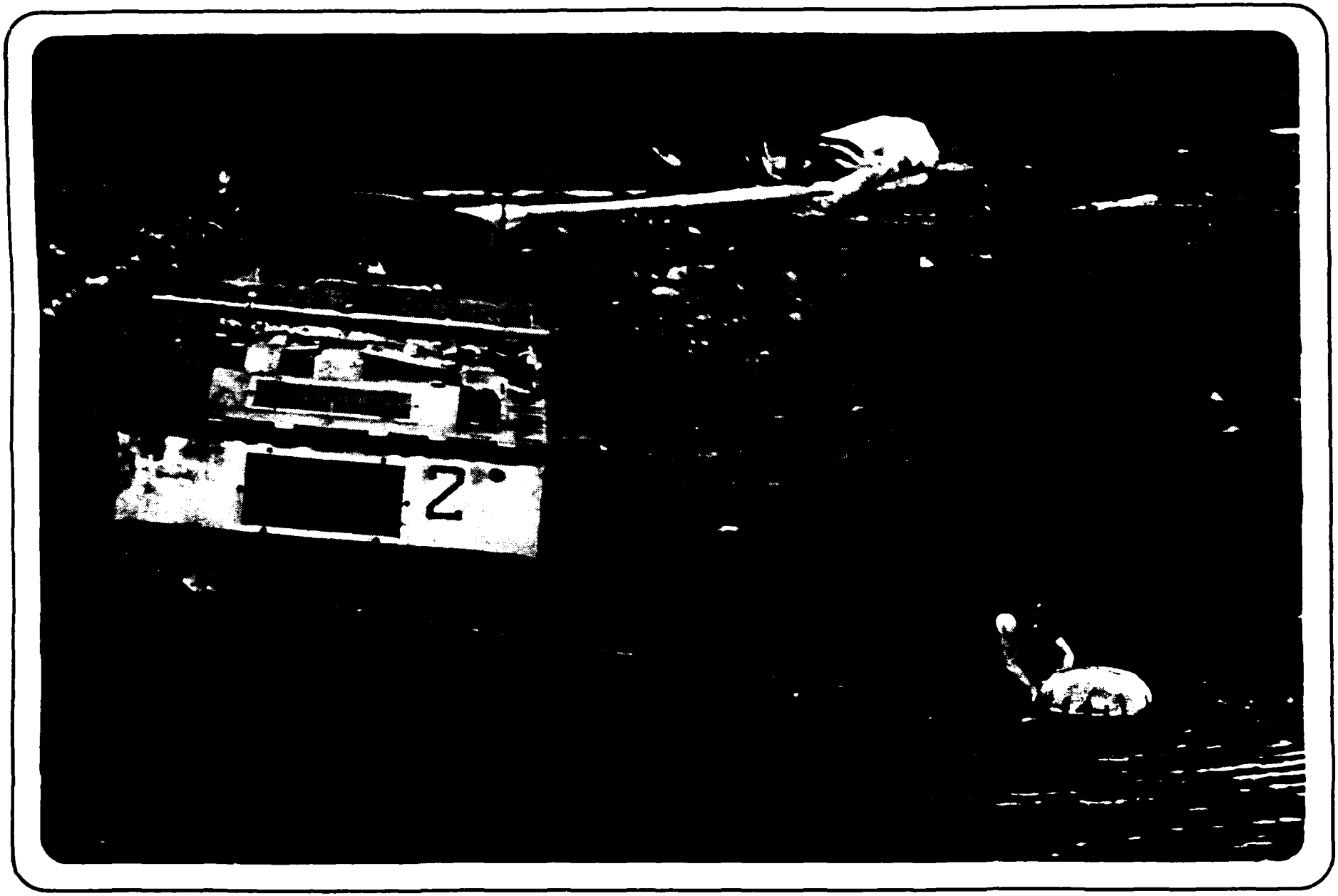


FIGURE 36: DIVER CUTTING OFF FLOATS PRIOR TO LARC TAKING CABLE ASHORE ON TATOOSH ISLAND

6.4 CABLE PROTECTION, STABILIZATION AND INSPECTION

Based on the cable route survey data, the Tatoosh Island shore site was the only one of the four that definitely required split-pipe protection with the pipe rock bolted into the bottom for stabilization. At both ends, Tatoosh Island and Neah Bay, the cable was trenched by land equipment on the beach and as far into the water (at low low water) as was possible. Beyond the protection zone it is expected that the cable will bury itself in the sand or mud bottom as a result of cable weight and sea movement due to weather, tides, and currents.

After the Cape Flattery installation UCT-2 Seabee divers inspected the installed cable from the beach to 80' depth off Tatoosh Island. Split pipe sections were installed on the cable at locations potentially hazardous to the cable. Rock bolts were used to secure and stabilize the split pipe sections to the bottom. A record of the location, and details of the process were maintained by UCT-2. At the Tatoosh Island end of the cable only the most critical points were protected and stabilized since environmental conditions were deteriorating rapidly during this phase of the operation. At present, there are installed six complete sections of split pipe in each of five locations along the approaches to Tatoosh Island. The UCT-2 inspection indicates that this type of protection is needed at some ten more locations in the same general area when the weather has sufficiently ameliorated.

A similar inspection was made at the Neah Bay end of the Cape Flattery installation; but it was found that cable protection and stabilization were not required.

7.0 DEMOBILIZATION AND RESTORATION

The *WHITE BUSH*, *POINT COUNTESS* and other Coast Guard vessels associated with the project have returned to standard activities. The same is true of the Navy craft *LARC V* and the *ZODIAC*.

The YC-1092 cable-laying barge on loan from the Naval Torpedo Station, Keyport, Washington is presently moored in Port Angeles, Washington. The barge is configured, loaded and outfitted in the same fashion as during the Smith Island cable installation, in anticipation of installing cable from

Destruction Island to the mainland during the summer of 1977. The principal items aboard the barge include: 44,043 feet of RG-85 surplus communications cable; 2,000 feet of ITT cable; the CLAMM; the cable tensioner; the box beam frame structure; the three cable chutes; the cable brake; and miscellaneous cable-laying gear. Arrangements have been made with NTS Keyport to retain the barge for an undefinite period. Similarly, the agreement with the Alaska Power Administration cited no definite limit on the time for retention of the cable tensioner. Plans will be made to return this item after the Destruction Island installation.

The remaining ITT and RG-85 cable is stored at the 13th Coast Guard District cable storage facility in Astoria, Oregon. The remaining split pipe is presently stored at Makah Air Force Station, near Neah Bay. The unused split pipe will be shipped back to the CHESNAVFACENGCOM equipment pool if not utilized for Destruction Island or Cape Flattery during the 1977 summer period.

APPENDIX A

PROCEDURES FOR UNDERWATER CABLE ROUTE SURVEYS TO SMITH ISLAND, CAPE FLATTERY, AND DESTRUCTION ISLAND LIGHTHOUSES

Procedures for Underwater Cable Route Surveys to Smith Island, Cape Flattery, and Destruction Island Lighthouses

1. PROJECT DESCRIPTION

1.1 Background. The Chesapeake Division, Naval Facilities Engineering Command (CHESNAVFACENGCOM) provides support for the U. S. Coast Guard Lighthouse Automation and Modernization Program (LAMP). LAMP has as its goal the full automation of all Coast Guard lighthouses, which will enable the Coast Guard to remove its personnel from these outposts. CHESNAVFACENGCOM is supporting this project by installing underwater power cable to priority lighthouses. To accomplish this support, CHESNAVFACENGCOM has conducted feasibility studies, analyzed costs, investigated sites, surveyed cable routes, procured cable, performed project management, and installed cable.

1.2 Project Summary. The 13th Coast Guard District is in the process of automating two manned, off-shore lighthouses, Smith Island and Cape Flattery, and of converting the existing automated, unmanned Destruction Island Lighthouse from generator to shore power. A site investigation was performed at these lighthouses the week of 20 October 1975. A copy of the site investigation report is attached as Appendix B.

CHESNAVFACENGCOM, with the support of the 13th Coast Guard District and the U. S. Navy Underwater Construction Team - Two (UCT-2), will perform cable route surveys to the three lighthouses beginning 21 June 1976, for about ten days.

1.3 Site Locations. The three lighthouses are all within 150 miles of the Seattle headquarters of the 13th Coast Guard District, see figure 1-1.

1.3.1 Smith Island Lighthouse

--50 miles north of Seattle, 6 miles west of Whidbey Island at 48° 19.1' N. latitude and 122° 50.6' W. longitude.

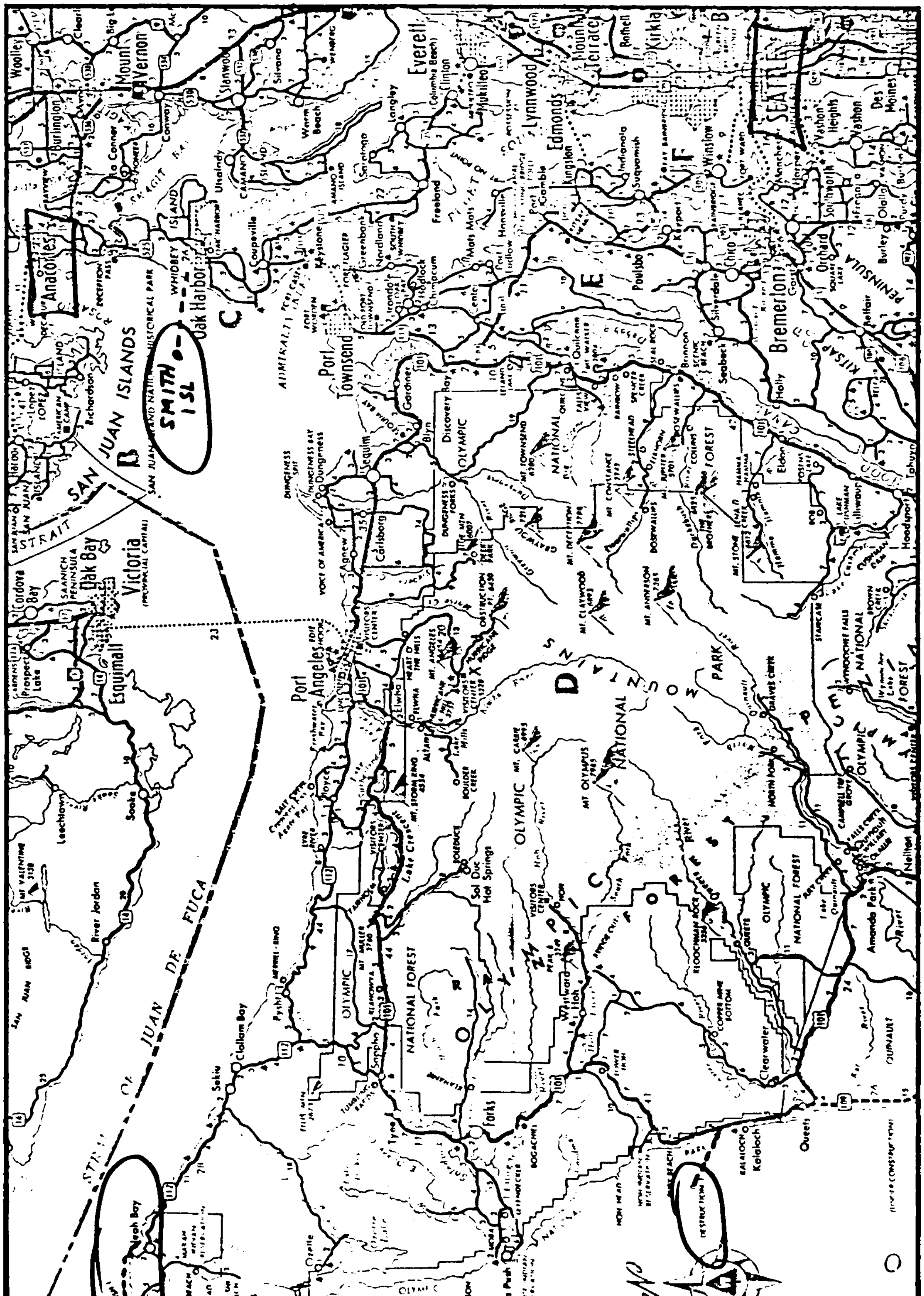
--The cable route is to be on a direct line from Smith Island to the power source near the beach on Whidbey Island. Its approximate location is 48° 18.5' N. latitude and 122° 43' W. longitude.

--The staging location for the Smith Island Lighthouse survey will be at the Coast Guard Station at Anacortes on Fidalgo Island, directly north of Whidbey Island. Auto access to Anacortes: Interstate 5 about 65 miles north of Seattle, west on State route 20 to Anacortes.

--Applicable charts for Smith Island Lighthouse: C&GS 6382, 6401, 6380, 6450, 184 Small Craft and 6300 (Cape Flattery also); Geological Survey 15-minute series topographic maps with titles in State of Washington of Deception Pass, Richardson, and Anacortes.

1.3.2 Cape Flattery Lighthouse

--150 miles northwest of Seattle off Cape Flattery on Tatoosh Island at 48° 23.5' N. latitude, 124° 44.1' W. longitude.


STRAIT OF JUAN DE FUCA
SAN JUAN ISLANDS
Victoria
Esquimalt
Sooke
Port Angeles
Port Townsend
Sequim
Anacortes
Oak Harbor
SMITH ISL
Everett
Lynnwood
Edmonds
SEATTLE
Bremerton
Poulsbo
Forks
Clallam Bay
Neah Bay
La Push
OLYMPIC NATIONAL PARK
OLYMPIC NATIONAL FOREST
OLYMPIC MOUNTAINS

--The cable route will parallel the existing charted cable runs from the north side of Tatoosh Island, eastward to northwest Neah Bay (western end of breakwater to Waadah Island).

--The staging for Cape Flattery is to be at the Neah Bay Coast Guard Station. From Seattle, take ferry routes west to US 101; at Port Angeles, take State Highway 112 through Clallam to Neah Bay.

--Applicable charts for Cape Flattery Lighthouse: C&GS 6102 (Destruction Island also), 6265, and 6266; Geological Survey of Cape Flattery.

1.3.3 Destruction Island Lighthouse

--Located 150 miles west of Seattle about 60 miles down the coast from Cape Flattery, at 47° 40.5' N. latitude and 124° 29.1' W. longitude.

--The cable route will be on a direct line southeast from Destruction Island to the power source at a state highway maintenance station where US 101 runs only a few feet from the beach. The approximate beach location is 47° 37' N. latitude and 124° W. longitude.

--The staging for Destruction Island will also be at the Neah Bay Coast Guard Station.

--Applicable charts for Destruction Island Lighthouse: C&GS 6102 (with insert for town of La Push), C&GA 6002; Geological Survey, Destruction Island, Forks, and La Push.

1.4 Survey Schedule. The survey schedule is tentatively based on: (a) the operational capability of the Coast Guard support vessel; (b) the weather; and, (c) the survey findings, which may warrant additional investigation.

1976

21 June - Monday	- Planning meetings at Anacortes; load and install gear on support vessel USCGC POINT COUNTESS.
22 June - Tuesday	- Transit to Smith Island Lighthouse area; establish locations for navigation instruments; perform depth recording runs.
23 June - Wednesday	- Perform diver surveys at planned shore approach of cable at Smith and Whidbey Islands.
24 June - Thursday	- Transit to Neah Bay for survey to Cape Flattery Lighthouse.
25 June - Friday	- Establish navigation locations to perform bottom depth recording runs.
26 June - Saturday	- Perform diver surveys at Tatoosh Island (Cape Flattery Lighthouse) and at planned terminal of cable near Neah Bay.

27 June - Sunday - Contingency and/or weather day; transit to location for survey to Destruction Island Lighthouse.

28 June - Monday - Establish navigation locations and perform bottom depth recording runs.

29 June - Tuesday - Perform diver surveys at Destruction Island and at shore terminal.

30 June - Wednesday - Off load equipment and transmit to Seattle area.

1.5 Support Vessel. The U. S. Coast Guard cutter POINT COUNTESS (WPB 82335) has been tasked to support the surveys at each of the three sites. The POINT COUNTESS is an 82-foot patrol craft, similiar to other Coast Guard cutters used successfully for the Chesapeake Bay and Long Island Sound cable route surveys. The vessel is based in Port Angeles, Washington, on Juan De Fuca Strait (somewhat equidistant between the three lighthouses). It will overnight at the two Coast Guard stations to be utilized as staging areas for the lighthouse surveys.

While no berthing is available on the cutters, occasional messing privileges can be arranged while operating at sea, or the use of the galley for the preparation of meals is permitted.

Two large holds aft can be used to store project and diver gear. In addition, 120-volt AC is available, and 24-volts DC may be available for navigation equipment.

A 16-foot powered boat is carried on the after deck and can be launched by boom. Diver operations can be conducted from this small boat or from a SEABEE Zodiac inflatable craft.

2. ORGANIZATIONAL RESPONSIBILITIES

2.1 CHESNAVFACENGCOM. CHESNAVFACENGCOM is under an interagency agreement with the Coast Guard Headquarters in Washington, D. C., to accomplish power cable installations for the various Coast Guard districts. For the cable route surveys to Smith Island, Cape Flattery, and Destruction Island, CHESNAVFACENGCOM will provide:

--Overall project engineering, management and coordination.

--Interface between all project participants.

--Navigation equipment and procedures.

--A project manager, assisted by a CHESNAVFACENGCOM engineer.

--Documentation responsibility, including a survey report.

The contact is: CHESNAVFACENGCOM
Building 57, Washington Navy Yard
Washington, D. C. 20374
202-433-3881 (Autovon 288-3881)
Code FPO-1C3 Hal Dorin

2.2 13th Coast Guard District. The 13th Coast Guard District has been generously supporting all phases of this project's goal: the installation of underwater power cables to Smith Island, Cape Flattery, and Destruction Island Lighthouses. For the cable route survey phase, the 13th Coast Guard District will provide:

--An 82-foot Coast Guard cutter as a survey platform.

--The support of various Coast Guard stations and the 13th Coast Guard District Headquarters.

--Electrical power aboard the cutter, the use of eight 12-volt batteries for the field navigation stations, and the use of two battery chargers.

--Site clearances for access to the lighthouse islands and the proposed shore power terminal areas.

--A 13th Coast Guard District representative to serve as liaison between the Coast Guard and Navy (CHESNAVFACENGCOM and UCT-2 SEABEE) units.

The contact is: Thirteenth Coast Guard District
Civil Engineering Branch
915 2nd Avenue
Seattle, Washington
206-442-5807
Lt. Greg Magee

2.3 UCT-2. UCT-2 has been able to schedule support for both the surveys and the planned September 1976 installations of the three cables. For the survey phase, UCT-2 will provide:

--A five-man diving and survey team, with the necessary diving equipment and supplies, who will inspect underwater cable approaches to the lighthouse islands and the shore landings at the power source end.

--Diver personnel to assist the navigation aspects of depth recording runs during nondiving periods.

--Certain navigation equipment, such as a portable depth recorder, transits (2), and tripods for transits (2).

--A written report (with underwater photographs) of the diving aspects of the survey.

The contact is: Thirty-First Naval Construction Regiment
Underwater Construction Team - Two
Port Hueneme, California 93041
805-982-5911 (Autovon 360-5911)
Lt. Bill Walker

3. SURVEY AND NAVIGATION EQUIPMENT AND PROCEDURES

3.1 Navigation Equipment. The following navigation equipment will be used for the lighthouse surveys:

--Motorola Mini-Ranger console with 2 transponders, 2 tripods for the transponders, 24-volt batteries to supply direct current to the console and transponders, and electrical cables for all units.

--Two transits, with tripods (UCT-2).

--Portable depth-recording system (UCT-2).

--Miscellaneous navigation tools and equipment.

--Navigation charts.

--Eight 12-volt batteries, with 2 battery chargers (13th Coast Guard District).

3.2 Shore End Diver Surveys. The SEABEE divers will perform diver surveys of the cable approaches to each lighthouse island and to each of the three mainland beach areas. Divers will inspect the sea bottom from the beach out to a depth of 60 feet along the cable route. The purpose of the surveys is to: (a) confirm the suitability of laying the cable along the planned route; (b) locate alternate approaches, if necessary; (c) identify obstructions or other bottom conditions that may be potentially hazardous to the cable and to record their location; (d) plot a route for placing the cable, should obstructions exist; (e) take photographs of each of the underwater approaches; and (f) record all data for presentation in the survey reports.

Although navigation and communication conditions will vary somewhat with each site, the following procedures will prevail for each survey:

--Divers enter the water from the beach or a small boat.

--Divers follow the compass bearing to a depth of 60 feet (the depth will vary somewhat at each site), recording bottom conditions.

--The small boat accompanying the divers on the surface will contain radios to communicate with navigation personnel on the beach.

--If feasible, a Mini-Ranger transponder will be placed in the boat to identify the range. If not, a hand-held, optical Rangematic Distance Finder will be used.

--The beach navigation personnel will direct the boat along its proper bearing (transit), and record the range to coordinate it with each diver's report.

3.3 Smith Island Cable Route Survey

CHARTS: National Ocean Survey (C&GS) 6450 and 184-SC
MAP: Geological Survey - Deception Pass, Washington

Chart surveys of the route and information gained during the site investigation indicate that a cable route on a direct line between the lighthouse and the beach landing site would be feasible. The true bearing between Smith Island Lighthouse and the beach is 093° (273°T from beach to lighthouse). (A tank shown as a navigational aid is 019°T from the lighthouse, and an aero beacon and radio tower are both about 75°T from the lighthouse.)

The Mini-Ranger console, and the depth recorder will be set-up on board the POINT COUNTESS. A Mini-Ranger transponder and transit will be set-up on the mainland. And, if possible, a transit will be located near the top of the lighthouse.

The transit operators will direct the survey vessel along the track from beach to beach. Mini-Ranger and bearing recordings will be taken, keyed to the precise time. The depth recorder paper (roll) will be marked by time of day. All data taken will be identified as to lighthouse, data, run, time, and specific data recorded.

3.4 Cape Flattery Cable Route Survey

CHART: National Ocean Survey - (C&GS) 6265 and 6266
MAP: Geological Survey - Cape Flattery, Washington

Because of the circuitous route from Cape Flattery Lighthouse (Tatoosh Island) to Neah Bay, a Mini-Ranger transponder and a transit will be used at each end. Navigational plots, utilizing both Mini-Ranger and transit (and a plot for the transit alone, in the event the Mini-Ranger fails to operate), will be developed prior to the survey.

3.5 Destruction Island Cable Route Survey

CHART: National Ocean Survey - (C&GS) 6002
MAP: Geological Survey - Destruction Island, Washington

Similar to Smith Island, the route from Destruction Island to the beach will be on a direct line, 127° true bearing from the lighthouse to the beach (307° T from beach to lighthouse). Transits will be set up at each end to facilitate sighting the survey vessel over the long range.

4. ADDITIONAL FACTORS

4.1 Weather. Periodic weather conditions and forecasts will be received via the Coast Guard radio network.

4.2 Communications. In addition to Coast Guard radio equipment and frequencies, other walkie talkie-type radios, with frequencies assigned for this type of operation, will be utilized.

4.3 Transportation. CHESNAVFACENGCOM, UCT-1, and the 13th Coast Guard District will have their own vehicular transportation at each of the mainland sites.

APPENDIX B

REPORT OF
SITE INVESTIGATION DETAILS FOR POWER CABLE
INSTALLATION AT CAPE FLATTERY, SMITH ISLAND,
AND DESTRUCTION ISLAND LIGHTHOUSES

SITE INVESTIGATION DETAILS FOR POWER CABLE INSTALLATION AT CAPE FLATTERY, SMITH ISLAND, AND DESTRUCTION ISLAND LIGHTHOUSES

ATTACHMENT 1. Specification for Thirteenth Coast Guard District Armored Communications Cable (Surplus)

2. Specification of ITT Three Conductor Power Cable

TRIP SCHEDULE

1. The trip schedule was as follows:

A. Monday - 20 October 1975 - Conference at ITT, Hydrospace Division, San Diego, CA regarding the purchase of 60,000 feet of used underwater power cable which is being offered for sale by ITT for about one-tenth its new commercial value. CHESNAVFACENGCOM is in the process of purchasing this cable for use on Coast Guard LAMP Projects.

B. Tuesday - 21 October 1975 - AM - Meeting at 13th CGD Headquarters, Seattle, WA.

C. Tuesday - 21 October 1975 - PM - Investigation of shore sites for the landing of cable from Destruction Island Lighthouse and commercial power available near these sites.

D. Wednesday - 22 October 1975 - AM - Cape Flattery Lighthouse cable shore landing site survey at Cape Flattery, Waatch River Inlet, and Neah Bay.

E. Wednesday - 22 October 1975 - PM - Transit by Army helicopter from Coast Guard Station at Neah Bay to Destruction Island, Tatoosh Island (Cape Flattery Lighthouse), and Smith Island.

F. Thursday - 23 October 1975 - AM - Site survey on Whidbey Island for shore landing site of cable to Smith Point.

G. Thursday - 23 October 1975 - PM - Meeting at 13 CGD Headquarters, Seattle, WA.

POWER CABLE AVAILABILITY SUMMARY

1. The three underwater cables which can be used for the lighthouses are as follows:

A. The 13th CGD possesses upwards to 100,000 feet of armored coaxial communications cable, Attachment 1, which is evaluated to be satisfactory for use as underwater power cable.

(1) An analysis of this cable by CHESNAVFACENGCOM personnel showed that a transmission voltage of 2700 volts would be required to yield a system with a regulation of 7%. A current of 2.59 amps at the 7000 watt power level is well within the current capacity of the cable.

(2) Electrically, the cable appears more than adequate, assuming it will pass the tests implied by the specification sheet and has not been degraded by time and/or improper handling and storage. Laboratory tests to verify the present condition of the cable are recommended for a representative length of the cable. In addition, inquiries as to cable splicing equipment and techniques should be initiated by the 13th CGD.

B. The 60,000 feet of used ITT cable, set forth in Attachment 2 is a more traditional, double armored power cable. Additional signal conductors for communications and/or automation equipment control have been incorporated into the cable.

C. CHESNAVFACENGCOM is presently purchasing for other Coast Guard Lighthouse Installations a new 15KV two conductor, concentric neutral URD power cable. This cable can be obtained unarmored, with a heavy polythylene jacket for about $1.00 per foot. It can be manufactured in long single lengths limited only by reel size and shipping constraints. Lengths in excess of six miles on a cable reel are feasible. The 15KV size, although electrically excessive to most Coast Guard requirements, has been chosen for the greater conductor size (for tensile strength), and for its weight, and increased center conductor insulation.

SITE INVESTIGATION SUMMARY

1. Cape Flattery Lighthouse.

A. The existing cable route to Tatoosh Island appears to be a satisfactory route and will be surveyed for the new power cable. A favorable approach to the lighthouse appears to be into the protected sandy cove on the north side of Tatoosh Island. The cable run to northwest Neah Bay (western end of breakwater to Waandah Island) is about 6NM. A commercial power source (pole) is located a few feet from the proposed cable landing beach site.

B. Other cable landing sites around Cape Flattery (from Neah Bay to Waatch Point) were investigated. The sites were not considered favorable (although the cable runs were shorter) due to the lack of nearby commercial power and the hazardous shore approaches.

C. Cable Recommendation: The double armored ITT cable (the three power conductors offer redundancy) is the first choice, however, the armored surplus communications cable could be used if the ITT cable is not obtained.

2. Smith Island Lighthouse.

A. The route from Smith Island to Whidbey Island measures approximately 5NM. If Minor Island light were to be included, an additional 1 to 1.5NM of cable would be required. From chart indications, a cable approach to Smith Island from the southeast would provide the most favorable underwater bottom slope (no more than 10%). The on-site inspection of Smith Island revealed a gradual approach up the beach and along the southern side of the island.

B. Bottom depth recordings will be taken during the cable route survey to assist in determining the best route to Whidbey Island. Bottom consistancy across the shipping channel appears ideal, with mud and sand predominating.

C. The recommended cable landing site on Whidbey Island is at the southwestern tip of Ault Field/Naval Air Station (approximately 48° 18.5'N, 122° 42'W). Commercial power is available near the edge of the Navy beach property.

D. Cable Recommendation: The water depth, bottom consistancy, and tide/current/weather conditions appear to favor the use of unarmored concentric neutral URD cable. The cable should be protected and/or buried at each end. However, as an alternate, the 13th CGD surplus communications cable could be used for this cable run.

3. Destruction Island Lighthouse

A. Original chart estimates for the shortest cable runs to Destruction Island were 3 to 3½ miles. The site investigation revealed both unfavorable and land terrain conditions and the lack of power at these beach sites.

B. About one NM north of Kalalock, at the State Highway Maintenance Station on U.S. 101, the highway passes along the beach within 100 feet of the ocean. The height above sea level is 10-20 feet and relatively gradual. Commercial power is available along this section of the highway. The cable run from this site to Destruction Island is about 6NM over a sandy bottom not exceeding 60 feet deep. Either of the two coves on the east side of Destruction Island (one with sign marking cable crossing) appear to be favorable approaches to the island.

C. Cable Recommendation: The use of the 13th CGD armored surplus communications cable is recommended at this site. The cable, because of its weight, should bury itself in the sandy bottom.

SUMMARY OF CABLE USE RECOMMENDATIONS

1. The following table summarizes the various cable use options and cost of cable for various options. It should be noted that the use of the surplus 13th CGD communications cable will significantly lower LAMP program cable costs.

LIGHTHOUSE	CABLE LENGTH AND 10%	OPTION (1) ALL SURPLUS CABLE 0% SPARE OR SLACK	OPTION (2) ITT PLUS SURPLUS CABLE	OPTION (3) ITT PLUS NEW URD	OPTION (4) SURPLUS AND NEW URD	OPTION (5) NEW URD CABLE ONLY
Cape Flattery	6.5NM	Surplus communications cable	ITT	ITT	Surplus communications cable	New URD
Smith Island	5.5NM	Surplus communications cable	Surplus communications cable	New URD	New URD	New URD
Destruction Island	6.5NM	Surplus communication cable	Surplus communications cable	New URD	Surplus communications cable	New URD
COSTS (EXCLUDING SPLICING)		NONE	$30,000 to $50,000 for ITT	$30,000 to $50,000 for ITT plus $72,000 URD	$33,000 URD Surplus NONE	$111,000 URD

NOTES: (1) Cable Splicing Equipment costs about $3,500 for each cable type.

(2) Cable Costs: 10NM ITT, $30,000 Armored, as is, or $50,000 with additional jute wrapping (add reel costs); unarmored 15KV URD about $6,000 per NM.

(3) ITT Cable at Cape Flattery will have 3.5NM spare.
- Surplus cable, option (1), no spare cable.
- Surplus cable, options (2) or (4), 3-4NM spare.

CABLE ROUTE SURVEY SCHEDULE

1. The cable route surveys are usually scheduled for completion six months to one year before cable installations. However, in order to install cable during calendar year 1976, the following schedule is proposed:

Cable Route Surveys - June 1976

Cable Installations - September 1976

Weather and window constraints require that the installations be made by CHESNAVFACENGCOM during the above periods.

13th CGD SUPPORT ITEMS

1. Certain long lead action items should be scheduled for completion by the 13th CGD immediately following the above cable route surveys. These items are:

A. Contractual agreements with the respective commercial power companies for each of the three lighthouses. The agreements should include provisions for the power companies to accept the end of a cable and provide hook-up to the power source. The power company should provide power source transition equipment (pole, transformer, meter and/or other equipment) and maintenance and repair service to this equipment. In some instances, due to local or state requirements, it may be easier for the power companies to obtain the necessary easements or right-of-way.

B. Easements and/or agreements from landowners (whether Federal Government, State of Local Government, Private, or other) for installation of the cable on their land, whether submerged or dry should be obtained. An agreement, usually verbal, should also be obtained to allow access to the property for the cable route survey.

C. Obtaining all the necessary permits, including:

(1) Environmental Protection Agency (EPA) Negative Declaration is usually submitted.

(2) Corporation of Engineers Permit.

(3) State and Local Permits, if required.

(4) Advertisements, Declarations, Announcements, Public Hearings, etc., as required.

CABLE ROUTE SURVEYS

1. The Cable Route Surveys will be conducted to determine and chart the most favorable cable path, and to determine the extent of cable protection and stabilization required at each end. CHESNAVFACENGCOM will plan and direct the surveys with the assistance of Navy Underwater Construction Team Two (UCT-2), Port Hueneme, CA. Most of the equipment and personnel required will be supplied. The 13th CGD is requested to support the surveys with vessels, and to provide necessary clearances, access to property, notification of local authorities, etc.

CABLE INSTALLATION

1. CHESNAVFACENGCOM will also plan and direct all at-sea aspects of the Cable Installations and, with UCT-2, provide most of the equipment, personnel, and necessary supplies. Navy and/or Coast Guard Vessels will be utilized. Support required by the 13th CGD will be similar to the cable route survey. At each of the three locations, Tatoosh Island (Cape Flattery), Smith Island, and Destruction Island, the cable must be run a significant distance (and height) over land from the beach landing to the lighthouse area. The burial and/or other protection and stabilization of these cables from the beach to the lighthouses will be the responsibility of the 13th CGD. Similarly, at the power source end of each cable, the 13th CGD will be responsible for trenching and protecting the cable in accordance with the prevailing local codes. The distances at each of the power source ends should be no more than 100 feet. The power companies may consider including this task as part of their contracted agreement.

NOTIFICATION REQUEST

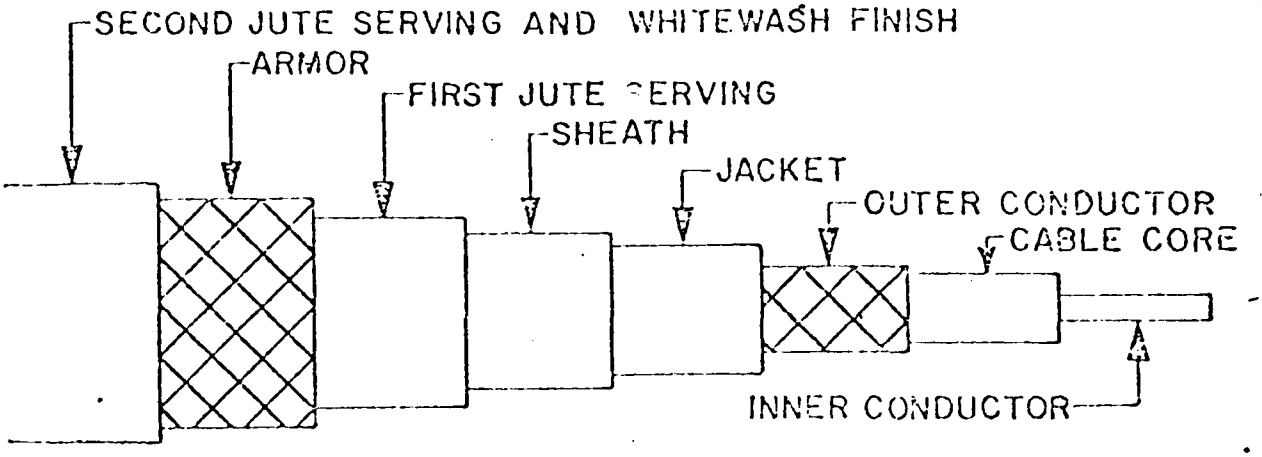
1. Due to vessel, personnel, and project commitments, it will be necessary for the 13th CGD to notify CHESNAVFACENGCOM in early June 1976 of its readiness and intention to proceed with the September 1976 installation. CHESNAVFACENGCOM contact is Mr. Harold P. Dorin, Code FPO-1C3, (202) 433-3881.

ATTACHMENT 1

Specification for
Thirteenth Coast Guard District
Armored Communications Cable (Surplus)

MIL-C-17/10A
4 MAY 1960
SUPERSEDING
MIL-C-17/10
7 SEPTEMBER 1955

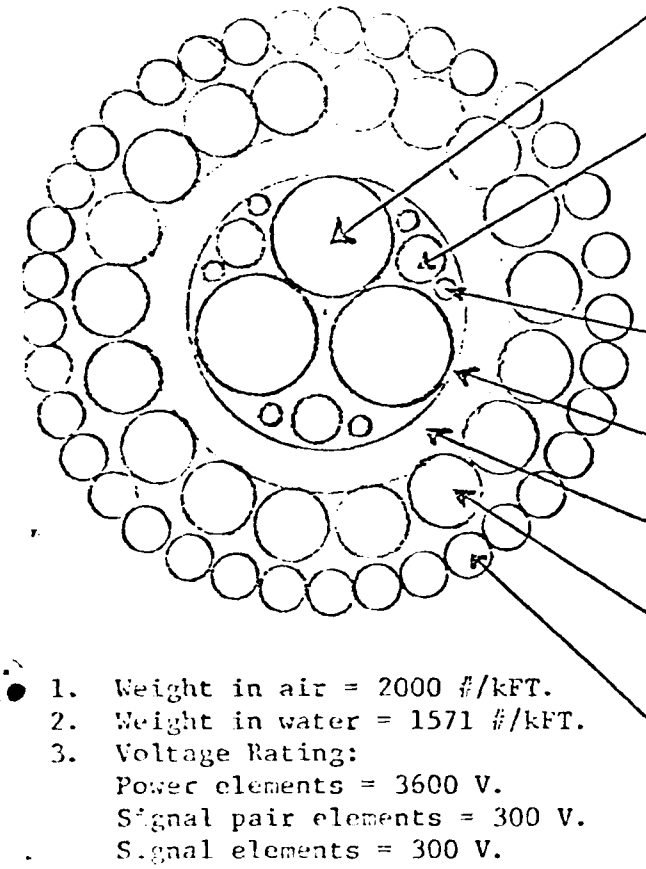
CABLE, RADIOFREQUENCY, COAXIAL, RG-85A/U



Description	Constructional details
Inner conductor	Bare copper wire. Nominal diameter, 0.1045 ±0.0015 inch.
Cable core	Solid, type A. Overall diameter, 0.680 ±0.010 inch.
Outer conductor	Single braid, AWG size 30 bare copper wire. Overall diameter, 0.760 inch maximum. *Alternate* Carriers ..... 24 ..... 36 ..... 48 Ends ..... 14 ..... 9 ..... 7 Picks/inch .... 3.1, ±10 percent .. 4.0, ±10 percent .. 5.6, ±10 percent
Jacket	Type IIa. Overall diameter, 0.870 ±0.015 inch.
Sheath	A lead sheath shall be applied over the jacket to a diameter of 1.000 ±0.015 inch. The sheath shall be of commercially pure lead (not less than 99.85 percent pure) and without flaws. It shall be tightly formed about the cable jacket. The sheath shall be applied concentrically to obtain a variation no greater than ±10 percent in the wall thickness of the sheath.
First jute serving	A serving of one layer of 70-pound asphalted jute, composed of 25 ends, shall be applied over the lead sheath with a left-hand lay of 4 ± ¼ inches. The asphalted jute shall be of the best commercial grade available.
Armor	A galvanized-steel-wire armor, BWG size 10, consisting of 24 wires shall be applied over the first jute serving with a right-hand lay of 9 ±1 inches. The wire shall be soft annealed wire, throughly and evenly galvanized. The wire shall have a tensile strength of not less than 50,000 pounds per square inch, and the elongation in 8 inches shall be not less than 12 percent, as tested before application to the cable.
Second jute serving	A serving of one layer of 16/3 asphalted jute, composed of a minimum of 27 ends, shall be applied over the armor with a left-hand lay of 3½ - ¼ inches. The asphalted jute shall be of the best commercial grade available.
Whitewash finish	A whitewash or other anti-stick material shall be applied over the second jute serving. The whitewash shall be made with the best slaked lime commercially available.
Completed cable	Overall diameter, 1.565 inches maximum

ATTACHMENT 2

Specification of ITT Three Conductor Power Cable



1.0 POWER ELEMENT: 3 UNITS:
#8 AWG (19/.0295") bare copper .148
wire .070" wall Copolymer .287

2.0 SIGNAL PAIR ELEMENT: 3 UNITS:
#20 AWG (7/.012") bare copper .036
.010" wall copolymer .056
2 - conductors twisted
Filled to round & over all
copolymer belt. .125
#36 AWG (.005") tinned copper .145
shield. Over all adhesive poly-
ester tape .150

3.0 SIGNAL ELEMENT: 6 UNITS:
#20 AWG (7/.012") bare copper .036
wire .015" wall copolymer .066

4.0 BINDER TAPE:
.0016" adhesive polyester tape .624

5.0 JACKET:
.060" wall high density black .746
polyethylene

6.0 INNER ARMOR:
19 - .128" galvanized improved .978
plow steel wire

OUTER ARMOR:
36 - .084" galvanized improved 1.146
plow steel wire

NOTE: Armor wires coated with
an anticorrosion compound.

1. Weight in air = 2000 #/kFT.
2. Weight in water = 1571 #/kFT.
3. Voltage Rating:
   Power elements = 3600 V.
   Signal pair elements = 300 V.
   Signal elements = 300 V.
4. dc resistance @ 20°C
   Power elements = .65 OHMS/kFT.
   Signal pair elements = 10.6 OHMS/kFT.
   Signal element = 10.4 OHMS/kFT.
5. Breaking strength = 100,000 lbs.
6. Torque at break = 73 in. LB
7. Impedence of pair = 78 OHMA at 50 kHz.
8. Attenuation of pair = 1.3 db at 50 kHz.
9. Capacitance of pair = 31pf/ft.

APPENDIX C

DESCRIPTION OF CABLE LAYING MACHINERY,
INSTRUCTIONS FOR SPLICING CABLE, AND
SUMMARY OF CABLE UTILIZATION

THE CABLE LAYING AND MAINTENANCE MACHINE (CLAMM)

The following description of the CLAMM has been excerpted from an article by CDR C. L. Clark, Chief, Civil Engineering Branch, Thirteenth Coast Guard District:

The key to reliable power and communications transmission via submarine power cable is the availability of properly equipped and trained personnel to periodically inspect, repair and replace suspect segments of the system. The Thirteenth District has always had well qualified personnel to maintain the sixty miles of submarine cable, but was sorely lacking in the equipment department. Muscle power and a 40 ft. UTB were the only tools available for maintenance in restricted waters. As a result, only an actual cable failure got attention.

Acquisition of an excess Cable Maintenance LCM was seriously considered. Transportation and overhaul costs would have exceeded $25,000. The LCM had additional operational drawbacks. Cable operation across the various inlets along the Washington and Oregon coast required hazardous transit in the open sea. Effective operation requires an assigned crew augmented by personnel with "logical Knowledge" while crossing the coastal bars. Cable repair and laying operations by LCM are possible but retrieval of abandoned cables would still take a lot of "Norwegian steam". Removal of as many as six abandoned cables at some sites was essential to permit future location and repair of the cable in service. Frustrating hours of retrieving dead cables had to be eliminated.

A joint effort of the Civil Engineering Branch, Electronic Engineering Branch, and a Seattle company specializing in custom power line and telephone construction equipment produced the design for CLAMM. The complete machine cost $10,040. Modifications to its Puget Sound barge added $5,627 to the system total.

CLAMM is easily transported by truck to any site. Rental of a small barge at the coastal ports is no problem. Ninety percent of our cable work is in Puget Sound so it is normally on its own barge. Improved safety and cleanliness adds to our satisfaction with CLAMM.

Two views of the CLAMM in operation aboard the USCGS *WHITE BUSH* are shown in Figures C-1 and C-2.

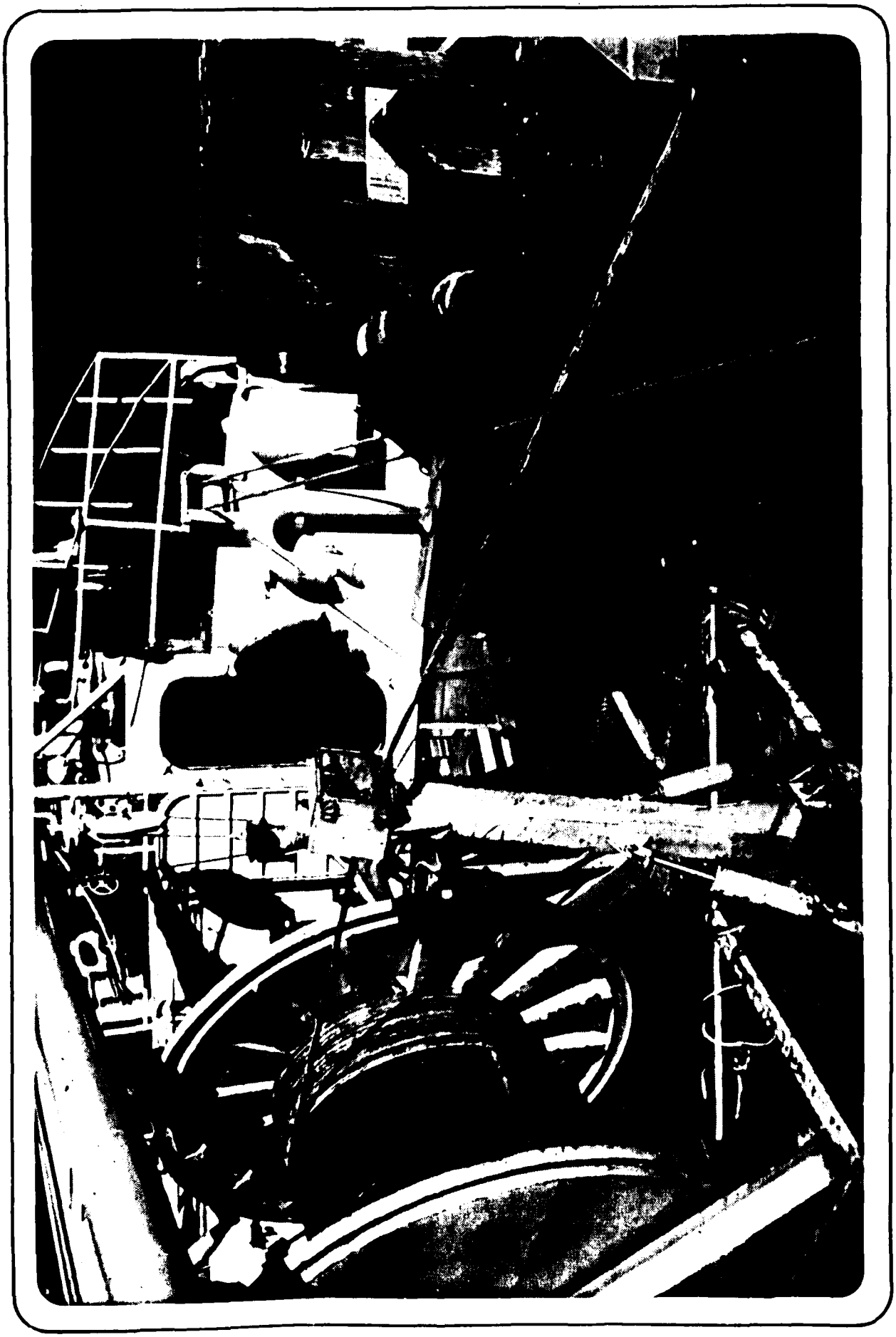


FIGURE C-1: ITT CABLE BEING LOADED ON THE CLAMM DRUM ABOARD THE USCGC WHITE BUSH

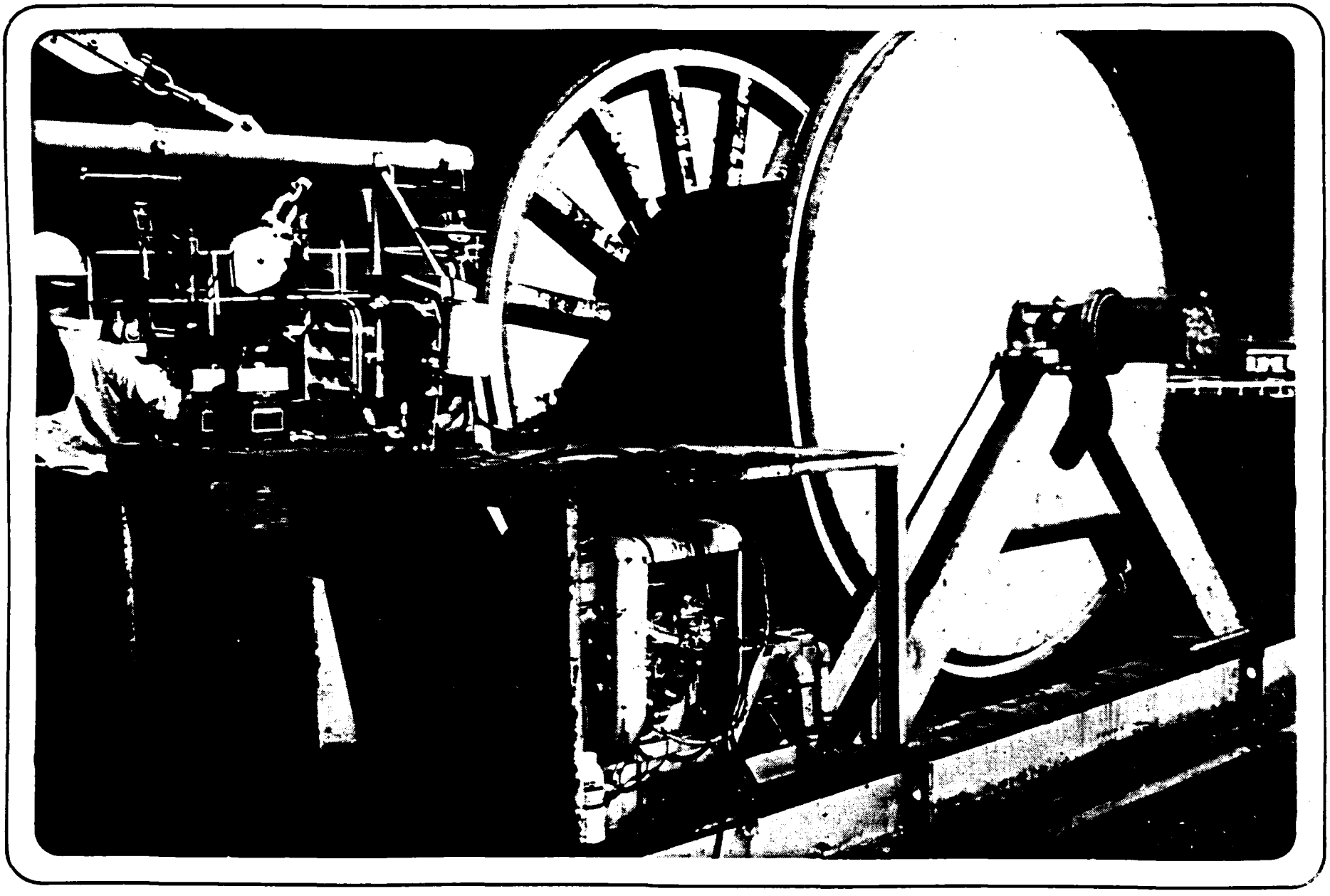


FIGURE C-2: THE CLAMM ABOARD THE WHITE BUSH DURING CABLE LAYING

Principal characteristics of the CLAMM are as follows:

Dimensions

Length	- 16' 0"
Width	- 8' 0" (less winch drum and operator's pedestal)
Width Overall	- 11' 0" can be reduced to 8' wide for road transportation
Height	- 8' 10"
Weight	- Approximately 9000 lb.

Reel Dimensions

Outside Diameter	- 96"
Core Diameter	- 48"
Core Width	- 52"

Reel Capacity

1 1/4" Cable - 16000' (Approximately)

Drive Train

Power - 18 HP Wisconsin Air Cooled Engine
Dusterion #63/5 Hydraulic Motor
Chain (Double Sprocket) from motor to reel

Controls

Forward-Neutral-Reverse
Continuously adjustable speed and power in both Forward and Reverse
Level wind guide arm - left-right adjustable speed

Working Data

Reel speed is continuously adjustable from 0 feet per minute (FPM) of cable payout - take in to a maximum speed of 300 FPM. Reel operates at same speeds in both Forward and Reverse.

Reel provides a minimum pull of 500 lbs at 300 FPM and is continuously adjustable to a maximum pull of 5000 lbs at 5 FPM. (Tested reel to 5500 lbs.)

THE CABLE TENSIONER

A cable tensioner was developed by Jacobson Brothers Towing Company of Seattle, Washington for an earlier project of the Alaska Power Commission. This unit was located by CHESNAVFACENGCOM in Snettisham, Alaska and arrangements were made for the unit to be loaned to the Coast Guard for this particular aspect of the LAMP project. The 13th Coast Guard District arranged to have the unit transferred to the manufacturer in Seattle for overhaul and repair and thence to Port Angeles where it was installed aboard the YC-1092 on 7 October 1976.

An overall view of the cable tensioner installed on the cable laying platform is given in Figure C-3 and additional details are shown in Figures C-4 and C-5. This tensioner is a non-powered braking and fairleading device which allows the cable to be payed out from a bin storage under a controlled level of tension.

The unit consists of four pairs of automobile wheels with the eight individual axles vertical so that all wheels are in the same horizontal plane. The tires fitted on the eight wheels have a smooth tread and are grooved around the periphery to the size of the cable as shown in Figure C-4. The rollers, also shown in Figure C-4, between upright channels welded to the base, were installed for this project to maintain the cable at the proper height for engagement between the tire grooves.

The four axles in one row were fixed to the frame. The axles of the four opposing wheels were each fitted with lead screws so that the wheels could be moved transversly thus pressing the cable into the grooves between opposing wheels. During the initial laying of the RG-85 cable at Smith Island, these lead screws were successively backed off and retightened to allow the passage of splices. However, it was soon found that there was sufficient compliance in the tires to allow undamaged passage of the splice without changing the relative axle positions.

The eight automobile wheels were each fitted with standard band brakes; the brake cylinders were connected to a common hydraulic system. As shown in Figure C-5, hydraulic pressure was developed by a hand pump. This pump was operated to bring the brake pressure up to a level which produced the desired tension in the cable as it payed out over the stern and when the gage indicated this level, the system was isolated with the shut-off valve.

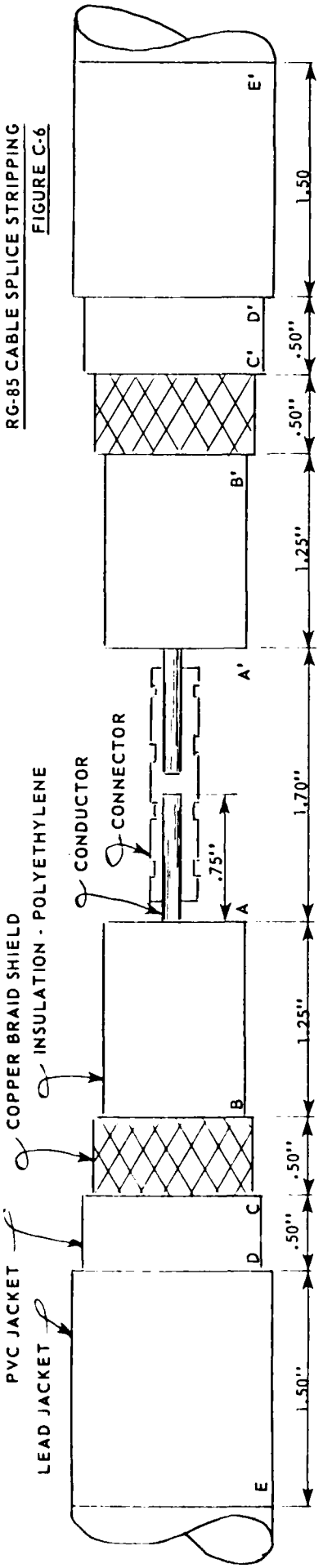
SPLICING INSTRUCTIONS FOR THE RG-85 COMMUNICATIONS CABLE

The following cable splicing instructions were furnished by the Hexcel Corporation, Rezolin Division, 20701 Nordhoff Street, Chatsworth, California. A representative of this company instructed Coast Guard telephone technicians in this splicing operation which was performed in Astoria, Oregon as the RG-85 surplus communications cable was being loaded aboard the YC-1092.

FIGURE C-3: OVERVIEW OF THE CABLE TENSIONER ABOARD THE YC-1092

FIGURE C-4: RG-85 CABLE RUNNING THROUGH THE CABLE TENSIONER

FIGURE C-5: BRAKE CONTROL SYSTEM ON THE CABLE TENSIONER



Materials Required

- o RG-85 Cable Splice Kit
- o Hotsplicer #4-087-075 Mold Assembly
- o Hotsplicer #9-124-125 Mold Assembly
- o Hotsplicer Mold Holder
- o Hotsplicer Mini-Press Frame
- o Ancillary Items

General Cable Preparation

- o Use a hacksaw to circumferentially cut through the lead cable jacket.
- o 3" from each cable end and remove this section of cable jacket, Figure C-6.
- o Remove 2 1/2" of PVC jacket from conductor end leaving 1/2" of PVC jacket exposed adjacent to original lead cable jacket.
- o Remove 2" of copper braid shielding from conductor end leaving 1/2" exposed copper braid adjacent to PVC jacket as noted in step above. Wrap masking tape around copper braid to prevent unraveling.
- o Remove .70" of polyethylene insulation from conductor end leaving 1 1/4" of exposed polyethylene insulation adjacent to exposed copper braid shield from step above.
- o Repeat steps above for the end of each cable to be spliced.

Splicing of RG-85 Cable

- o Place a Burndy connector #YDS-8W on exposed conductor wire of two cable ends.
- o Crimp the connector in position using a Burndy MD6 crimping tool with a #W171-1 die.
- o After crimping the connector check the distance between the ends of the exposed polyethylene insulation of the two conductor ends using a vernier calipers. (Ref. distance between point A and point A' on Figure C-6) The distance between point A and point A' must be at least 1.7" so the #937 preform will fit snugly over the crimped splice.
- o If the distance between point A and point A' is less than 1.7", use a sharp knife to cut away enough polyethylene insulation to make this distance 1.7".

Reinsulation of Completed Splice

- On each side of the connector sand the 1 1/4" of exposed polyethylene insulation and 1/2" of exposed PVC jacket with #180 grit Aloxite Cloth.
- Sand 1 1/2"-2" of each lead cable jacket end with #180 grit Aloxite Cloth until it is clean and bright.
- Clean the sanded polyethylene insulation, PVC jacket and lead cable jacket with 1,1,1 Trichloroethane or other suitable solvent.
- Bolt the Hotsplicer Mold Holder to the Mini-Press frame.
- Bolt the #4-087-75 mold assembly into position in the mold holder.
- Clean the mold halves with 1,1,1 Trichloroethane or other suitable solvent.
- Lightly spray each half of the mold with #900 Mold Release and wipe out excess with a clean rag or paper towel.
- Adjust the cable support clamps of the Mini-Press frame so they will hold the cable in the proper position and plane.
- Insert the thermometers into the holes in the mold holder, close the mold holder and begin heating with a propane torch.
- The tip of the torch should be approximately 1 1/2" from the mold holder and the flame directed at the middle of the back of the holder.
- When the thermometers read 350°F, shut off the propane torch.
- Put one half of the #937 preform in the bottom half of the mold and position the spliced cable over this half of the preform.
- Place the other half of the preform over the top of the cable and close the top half of the mold holder.
- Slowly tighten the six Allen bolts in the mold holder until the mold is 3/32" from being entirely closed.
- Wait 10 minutes and then start to gradually cool mold ends, top and bottom of the mold with water.
- When the temperature of the mold reaches 150°F, tighten the six bolts down further until the mold is 1/16" from being entirely closed.
- Continue cooling the mold with water.
- When mold temperature reaches 100°F, completely close the mold and cool to room temperature with water.
- After 5 minutes, remove the splice from the mold.
- Rebuild the copper braid shield by applying 2 half lapped layers of #217 copper braid over and between the exposed copper shield braid of the two conductor ends. Tack solder the #217 copper braid to the original copper braid.
- Apply one coat of #602 Bonding Agent over the 1 1/2"-2" of sanded bright lead cable jacket. Let the bonding agent air dry for 20 minutes.
- Apply one layer of butt wrapped #203 Insulating Tape over the primed lead cable jacket, PVC jacket and copper braid.
- Apply one coat of #610 Bonding Agent over the #203 Insulating Tape and let air dry for 15 minutes
- Wrap butt lapped layers of #230 Jacketing Tape over the splice area until a wrap diameter of 1 1/4" is reached (check wrap diameter with vernier calipers).

Molding of Wrapped Splice

- Bolt mold assembly #9-125-125 into place in the mold holder.
- Clean the mold assembly with 1,1,1 Trichloroethane or other comparable solvent.
- Spray the mold with #900 Release Agent and wipe out excess with a clean cloth or paper towel.
- Heat the mold assembly to 425°F using a propane torch. When 425°F is reached turn off torch.
- Cut 5 strips of #230 Jacketing Tape 9" long and place on top of one another. Cut the stacked strip of #230 Tape in half lengthways (9" length).

Molding of Wrapped Splice (Cont'd)

- o Place one pile of cut strips in the bottom of the mold.
- o Put the wrapped cable into the bottom half of the mold. (Note: Before placing cable into mold be sure temperature is 425°F).
- o Place the other pile of cut #230 Tape on top of the wrapped splice in the mold.
- o Close the mold and tighten the Allen bolts until the mold is 1/16" of being closed
- o Air cool the mold to 250°F.
- o When 250°F is reached, gradually cool the mold to 200°F with water.
- o When the mold is at 200°F completely close the mold by tightening the Allen bolts.
- o Cool the mold to room temperature by pouring cold water over the mold. Final cooling of the mold will take approximately 10 minutes.
- o When the mold reaches room temperature, open the mold and remove the molded splice.

A completed splice of the RG-85 cable is shown in Figure C-7.

SUMMARY OF RG-85 COMMUNICATIONS CABLE UTILIZATION

REEL LOADING ORDER	LENGTH OF CABLE REEL IN FEET	CUMULATIVE LOADED CABLE LENGTH IN FEET	SPLICE NUMBER	SPLICE IDENTIFICATION COLOR CODE
35	1790	80,494		
34	1500	78,704	34	BROWN RED BROWN
33	2111	77,204	33	GREEN RED GREEN
32	2198	75,093	32	ORANGE RED ORANGE
31	1600	72,895	31	BLUE RED BLUE
30	1615	71,295	30	SLATE WHITE SLATE
29	2019	69,680	29	BROWN WHITE BROWN
28	3290	67,661	28	GREEN WHITE GREEN
27	3266	64,371	27	ORANGE WHITE ORANGE
26	2100	61,105	26	BLUE WHITE BLUE
25	3285	59,005	25	SLATE VIOLET
24	2060	55,720	24	BROWN VIOLET
23	3222	53,660	23	GREEN VIOLET
22	3300	50,438	22	ORANGE VIOLET
21	3190	47,138	21	BLUE VIOLET
20	3306	43,948	20	SLATE YELLOW
19	2580	40,642	19	BROWN YELLOW
18	2100	38,062	18	GREEN YELLOW
17	2085	35,962	17	ORANGE YELLOW
16	3275	33,877	16	BLUE YELLOW
15	2009	30,602	15	SLATE BLACK
14	2025	28,593	14	BROWN BLACK
13	2000	26,568	13	GREEN BLACK
12	3270	24,568	12	ORANGE BLACK
11	1858	21,298	11	BLUE BLACK
10	2245	19,440	10	SLATE RED
9	1800	17,195	9	BROWN RED
8	450	15,395	8	GREEN RED
7	2850	14,945	7	ORANGE RED
6	3175	12,095	6	BLUE RED
5	2130	8,920	5	SLATE WHITE
4	1140	6,790	4	BROWN WHITE
3	1950	5,650	3	GREEN WHITE
2	1050	3,700	2	ORANGE WHITE
1	2650	2,650	1	BLUE WHITE

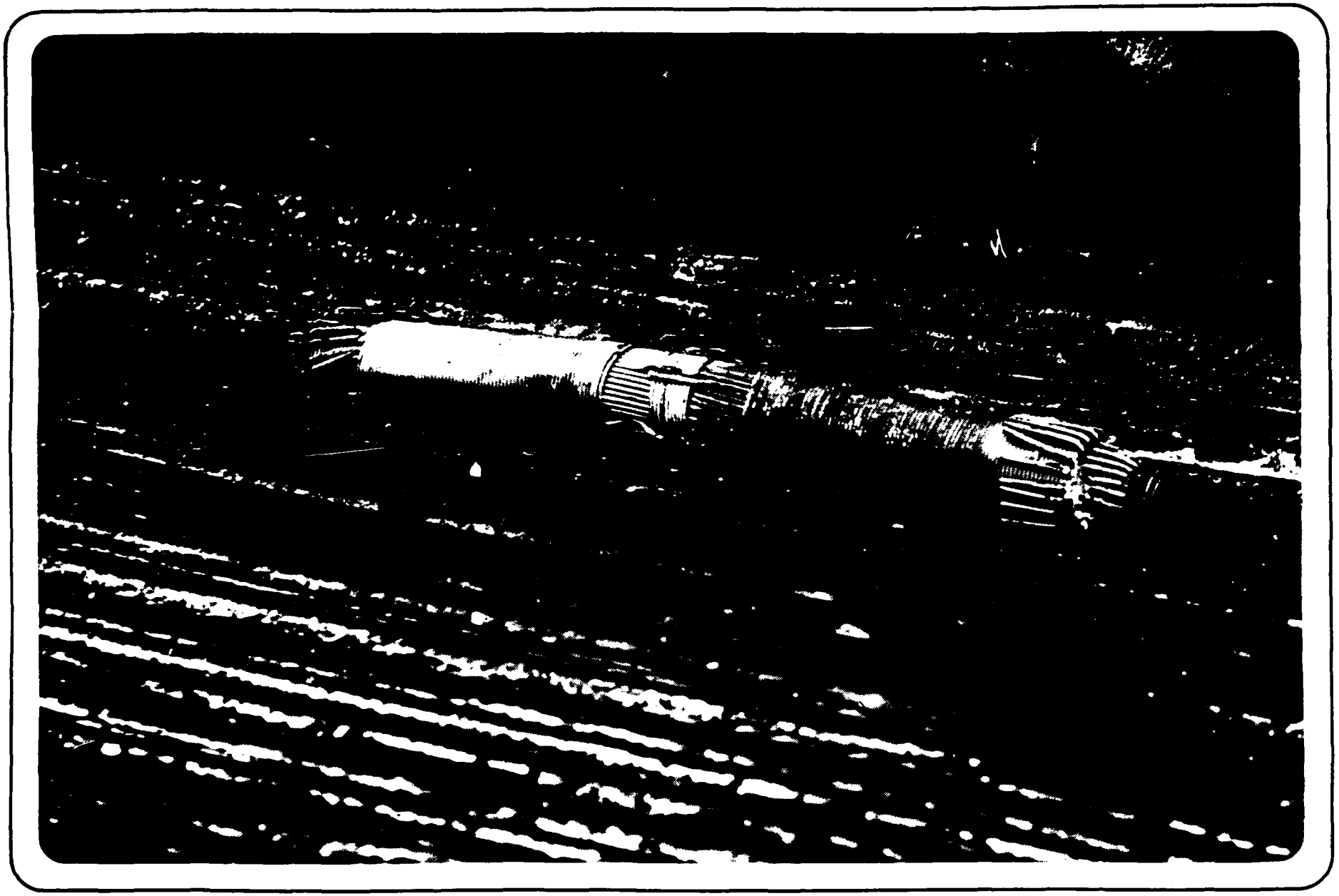


FIGURE C-7: COMPLETED AND COLOR CODED SPLICE OF THE RG-85 COMMUNICATIONS CABLE

The foregoing table delineates the order in which the RG-85 communications cable was loaded on the cable-laying barge YC-1092. When the cable laying started at Smith Island, splice #34 was the first one to enter the water. Splice #21 was the last splice in the water at the Whidbey Island end of the run. The cable was cut off between splice #21 and splice #20, approximately 995 feet from splice #20. Thus some 44,943 feet of the RG-85 communications cable remains aboard the YC-1092 for later use at the Destruction Island site.

At the Whidbey Island end of the run there is 1595 feet of cable inshore of splice #21. The remaining 600 feet of what was reel #21 was cut off and sent to Smith Island to be used as required at that end of the cable run.

SPLICING INSTRUCTIONS FOR THE ITT POWER CABLE

The following instructions were provided to Coast Guard telephone technicians for performing the splices in the ITT power cable; armor preparation was covered separately.

General Cable Preparation

- Cut and remove polyethylene jacket back 10" from each end of cable being spliced. Clean all elements thoroughly with trichloroethane or other suitable solvent.
- Utilizing Hotsplicer Mini-Press Frame and Mini-Press frame clamps, insert cable so that there is 10" between polyethylene cable jacket. Center cable in the frame and tighten clamps with elements (conductors) overlapping.

Splicing of Power Elements (Conductors)

- Cut away excess length of power elements and rejoin ends approximately in the center of the 10" space between polyethylene jacket. All other elements may be folded back so as not to interfere with power element splicing.
- Straighten elements of bends and kinks so that polypropylene sleeve may slide freely. Insert polypropylene sleeve over one end of power conductor at this time.
- Using a nylon string, cut insulation of both power conductors to be spliced. Remove enough insulation, approximately 1/2", so that Thomas and Betts No. 8 AWG stake-on-connector fits flush against insulation. Using the Thomas and Betts Stake-On tool, crimp connector. Solder may be applied to crimped connector to assure a tight connection. It is preferable to cut through the insulation using string or other suitable material instead of using a knife in order not to nick the copper conductor.
- After the connector has been crimped, slide the polypropylene sleeve over and centered on the crimped connector.
- Repeat the above four steps for the remaining two power elements.

- o Select one of the power elements to be bonded. Align the Vice-Grip Mold and the element, keeping the element as straight as possible and centered with the mold. After initial alignment of the mold, swing mold away from the element being careful not to disturb its alignment.
- o Insert the thermometer into mold, utilizing mold adapter. With butane torch, or some other means of heat, heat the mold evenly to 450° Fahrenheit. Remove thermometer from mold and quickly apply heated mold to polypropylene sleeve being careful that it is centered in the mold. Close the mold slowly keeping pressure even. Care should be taken that exposed insulation does not touch end of mold. NOTE: Mold may be heated above 450° Fahrenheit to allow cooling off period due to adverse weather conditions. The mold must not be allowed to cool below 450° while applying sleeve. This may cause an imperfect bond.
- o When polypropylene appears at each end of mold, cool mold to touch by quenching in water.
- o Remove mold from splice and inspect bond for imperfect fusion.
- o Repeat the last four steps on remaining two power elements.

Splicing of Non-Shielded Control Elements

- o Cut the six signal elements, leaving sufficient service slack, in such a manner as to have the six ends to be spliced, three to the right and three to the left of the finished power element splice.
- o Insert polypropylene sleeves over one end of the signal elements to be spliced.
- o Strip insulation back 1/2" with wire strippers, being careful not to damage the stranded conductor. Tightly twist ends together and apply solder.
- o Thoroughly clean the soldered signal element with trichloroethane.
- o Slide the polypropylene sleeve over and centered on the soldered joint.
- o Repeat the above five steps on the remaining five signal elements.
- o Insert the Vice-Grip Mold Adapters, being careful to keep them eligned and centered with the mold.
- o Select one signal element to be bonded. Align Vice-Grip Mold with its adapters, keeping signal element centered and straight as possible with the mold. After initial alignment of mold, swing mold away from the element being careful not to disturn its alignment.
- o Insert thermometer into mold. With the butane torch, heat mold evenly to 425° Fahrenheit. Remove thermometer from mold and quickly apply heated mold to polypropylene sleeve, being careful that it is centered in the mold. Close mold slowly keeping pressure even. Care should be taken that exposed insulation does

not touch end of the mold. Do not allow sleeve to remain in mold for more than 15 seconds after closing. Cool mold to touch immediately by quenching in water.

- o Remove mold from splice and inspect bond for imperfect fusion.
- o Repeat last four steps for remaining five signal elements.

Splicing of Shielded Signal Pair Elements

- o Cut the three shielded Signal Pair Elements, leaving sufficient service slack, in such a manner as to have the ends to be spliced offset from the other finished bonds.
- o Fold shield back being careful not to unlace or fray the ends. The shield will be reused later in the procedure.

  NOTE: There are three layers of copolymer insulation material over the shielded pair elements, one layer over each of the elements and one over the pair of insulated elements. This forms the outer jacket of the shielded pair elements. It is of the utmost importance that great care be taken when removing this outer jacket so as not to damage the insulation of the signal pair elements.

- o Beginning at the end of the pair elements, cut the outer jacket in such a manner that the jacket may be peeled free of the insulated pair. This may be removed back far as possible and discarded.
- o Insert polypropylene sleeves over one end of the pair of signal elements to be spliced.
- o Strip insulation back 1/2" with wire strippers, being careful not to damage the stranded conductors. Tightly twist ends together and apply solder.
- o Thorougly clean the soldered signal element with trichloroethane.
- o Slide the polypropylene sleeve over and center on the soldered joint.
- o Repeat the above seven steps on the remaining two shielded signal pair elements.
- o Insert the Vice-Grip Mold Adapters being careful to keep them aligned and centered with the mold.
- o Select one signal element to be bonded. Align Vice-Grip Mold, with its adapters, keeping signal element centered and straight as possible with the mold. After initial alignment of mold, swing mold away from conductor being careful not to disturb its alignment.
- o Insert thermometer into mold. With butane torch, heat the mold evenly to 425° Fahrenheit. Remove thermometer from mold and quickly apply heated mold to polypropylene sleeve being careful that it is centered in the mold. Close mold slowly keeping pressure even. Care should be taken so that exposed insulation

does not touch end of the mold. Do not allow sleeve to remain in the mold for more than 15 seconds after closing. Cool to touch immediately by quenching in water.

- o Remove mold from splice and inspect bond for imperfect fusion.
- o Repeat above four steps on remaining two shielded signal pair elements.
- o Rebuild the tinned copper shield by cutting all excess away and laying the shields over one another. Solder together to assure electrical continuity.

Outer Jacket Rebuilding

- o Using string, bind together the power elements, shielded signal pair elements and the non-shielded signal elements so as to achieve the smallest and most uniform diameter possible.
- o Sand and clean approximately 1" to 2" of existing polyethylene cable jacket.
- o Using polyethylene tape, wrap splice approximately 1/8" larger than the mold diameter, using calipers to check uniformity.
- o Cut ten strips, each strip being 10" long, of polyethylene tape and lay these aside.
- o Heat mold to 450° Fahrenheit. Lay five of the polyethylene strips, previously cut, in bottom half of the mold. Lay wrapped splice, centered in the mold. Lay five strips of polyethylene tape over top of splice. Close mold slowly and evenly. Let mold air cool to 275° Fahrenheit then continue cooling in water until mold has cooled to touch.
- o Remove the finished bond from the mold and inspect for imperfect bonding.
- o The finished splice is ready for enclosure by the armor.

The sequence of making such a splice as carried out aboard the USCGS *WHITE BUSH* during the Cape Flattery cable-laying operation is shown in Figures C-8 through C-11.

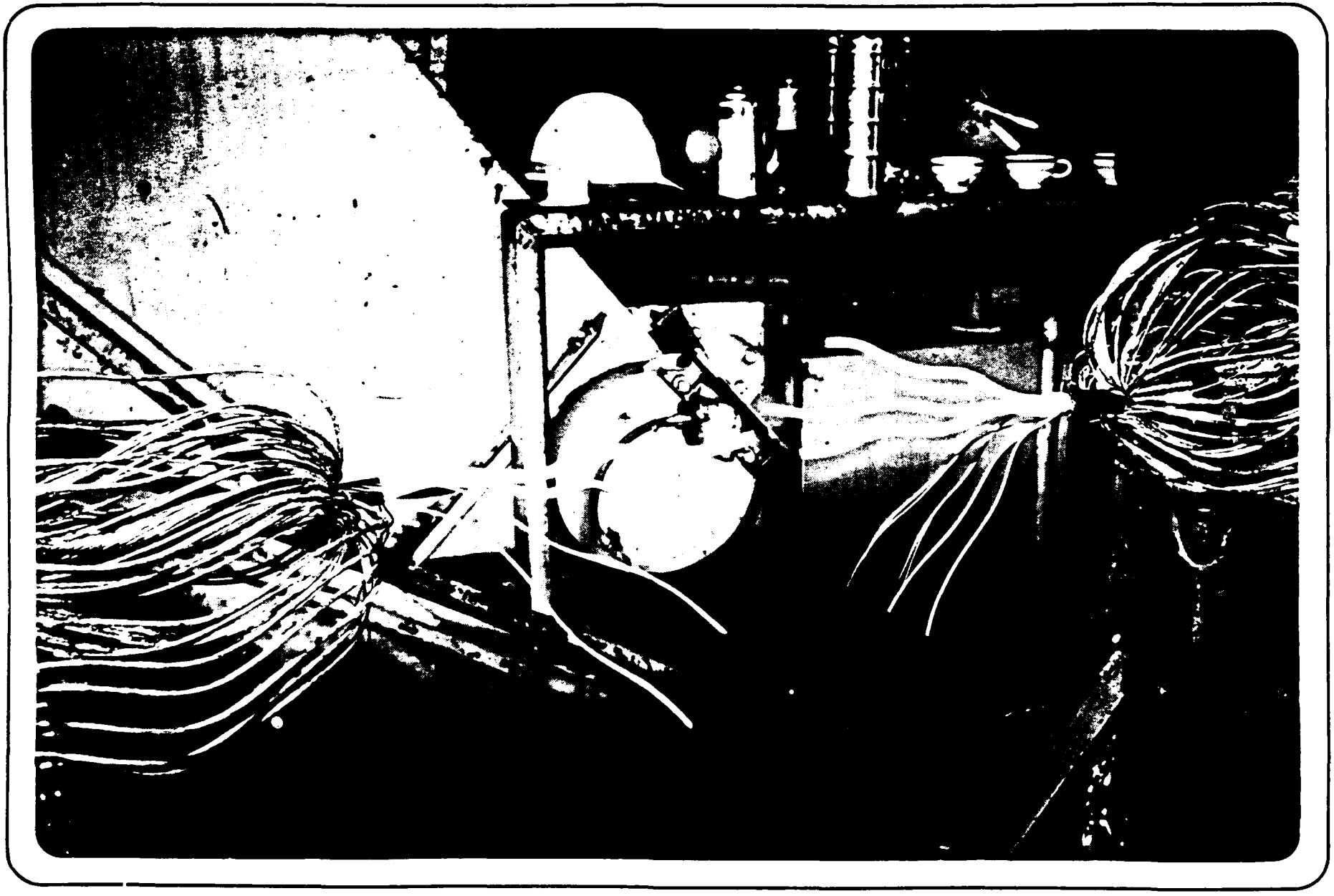
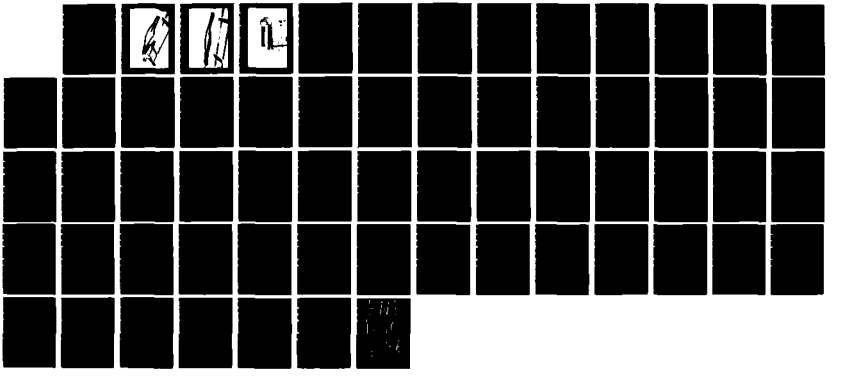
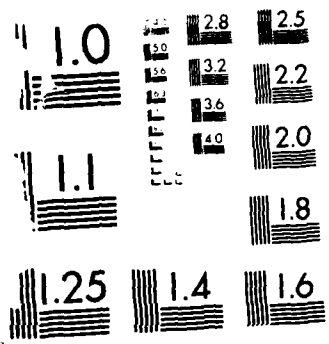


FIGURE C-8: STRIPPED ITT CABLE READY FOR SPLICING ABOARD THE WHITE BUSH

AD-A165 957 INSTALLATION OF UNDERWATER POWER CABLE TO SMITH ISLAND AND CAPE FLATTERY LIGHTHOUSES(U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE... JAN 77

UNCLASSIFIED CHES/NAVFAC-FPO-1-77(6) F/G 10/2 NL





MICROCOPY RESOLUTION TEST CHART

FIGURE C-9: SOLDERING ONE OF THE POWER CARRYING ELEMENTS OF THE ITT CABLE

FIGURE C-10: SLEEVE COVERING SOLDERED ITT POWER CABLE JOINT

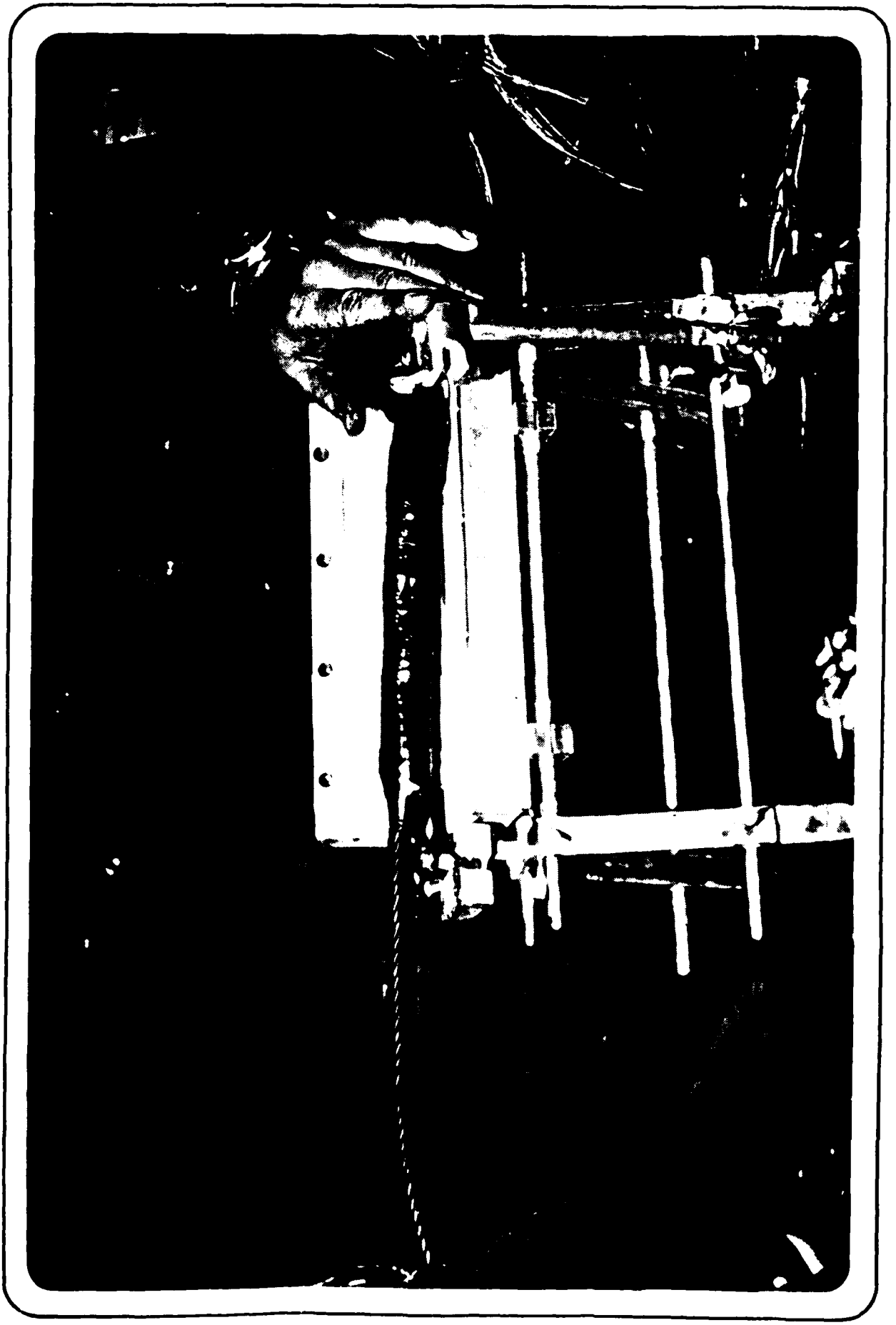


FIGURE C-11: MOLDING THE OUTER JACKET OF THE COMPLETED ITT CABLE SPLICE

SUMMARY OF ITT POWER CABLE UTILIZATION

Four reels of power cable were shipped by ITT to the U. S. Coast Guard Station at Astoria, Oregon. The lengths of cable on these reels were as follows:

- Reel #1 — 14,350 feet
- Reel #2 — 16,100 feet
- Reel #3 — 15,460 feet
- Reel #4 — 7,170 feet

The utilization of these four reels of ITT cable is delineated below.

Reel #1 - Laid from Tatoosh Island east toward Neah Bay

o Excess end length coiled at Cape Flattery Lighthouse	400 feet
o Length laid along shore from lighthouse to beach on Tatoosh Island	600 feet
o Length laid underwater along route to location of first splice	13,050 feet
o End length required for first splice dropped to bottom at splice location	300 feet
o Total length of cable utilized	14,350 feet

Reel #2 - Laid from first splice east to second splice

o End length required for first splice dropped to bottom at splice location	300 feet
o Length laid underwater along route from first splice to second splice location	15,000 feet
o End length required for second splice dropped to bottom at splice location	300 feet
o Excess cable remaining on reel (placed in wet storage at Neah Bay)	500 feet
o Total length of cable utilized	16,100 feet

Reel #3 - Laid from shore at Neah Bay out to second splice

o Length remaining on dock at Astoria near cable storage area	450 feet
o Length remaining in cable bay aboard YC-1092	2,210 feet
o Length laid along shore from power connection to beach at Neah Bay	400 feet
o Length laid underwater along route to location of second splice	7,600 feet
o End length required for second splice dropped to bottom at splice location	300 feet
o Length remaining on CLAMM cable reel at end of operation	4,500 feet
o Total length of cable utilized	15,460 feet

Reel #4 - This reel was not utilized and remained stored at the U. S. Coast Guard Station, Astoria, in the cable storage area.

APPENDIX D

DATA ON LARC V AND ON THE
BOSTON WHALER EXTRACTED FROM
THE OCEAN CONSTRUCTION PLATFORM COMPENDIUM

☐ GEOMETRY AND HYDROSTATICS: THE LARC V (LIGHTER AMPHIBIOUS RESUPPLY CARGO) IS A VEHICLE WHICH IS CAPABLE OF BEING OPERATED ON BOTH LAND AND WATER. THE AMPHIBIOUS LIGHTER HAS AN OVERALL LENGTH OF 35.00 FEET, A MAXIMUM WIDTH OVER THE FENDERS OF 10.00 FEET AND A MAXIMUM HEIGHT TO THE TOP OF THE CAB OF 10.17 FEET. THE TOTAL NET WEIGHT, DRY, IS 19,000 POUNDS WHILE THE TOTAL GROSS WEIGHT IS APPROXIMATELY 30,000 POUNDS. THE CARGO DECK, WHICH IS CAPABLE OF TRANSPORTING A MAXIMUM PAYLOAD OF 10,000 POUNDS, IS 16.00 FEET LONG, 9.75 FEET WIDE AND HAS A DEPTH OF 2.42 FEET. THERE IS A LOADED CLEARANCE OF 2.00 FEET BETWEEN THE HULL AND THE GROUND. AN OVERHEAD CLEARANCE OF 10.33 FEET IS REQUIRED FOR THE TRANSPORTATION OF THE LARC V.

☐ STRUCTURE: THE VEHICLE IS CONSTRUCTED WITH AN ALUMINUM FRAME SUPPORTING AN ALUMINUM HULL, DECK, AND CAB. THE LIGHTER IS MOUNTED ON FOUR RIGIDLY SUPPORTED WHEELS AND THE STRUCTURE IS DESIGNED TO SUPPORT THE TOTAL CRAFT WEIGHT ON DIAGONALLY OPPOSITE PAIRS OF WHEELS OVER THE RANGE OF VERTICAL ACCELERATIONS THAT MAY BE ENCOUNTERED. AN ALUMINUM CANOPY CAN BE INSTALLED TO COVER THE CAB IN THE CASE OF INCLEMENT WEATHER. THE FLUSH DECK HAS A HIGH CENTER OF GRAVITY WHICH FACILITATES THE SELF-BAILING FEATURE.

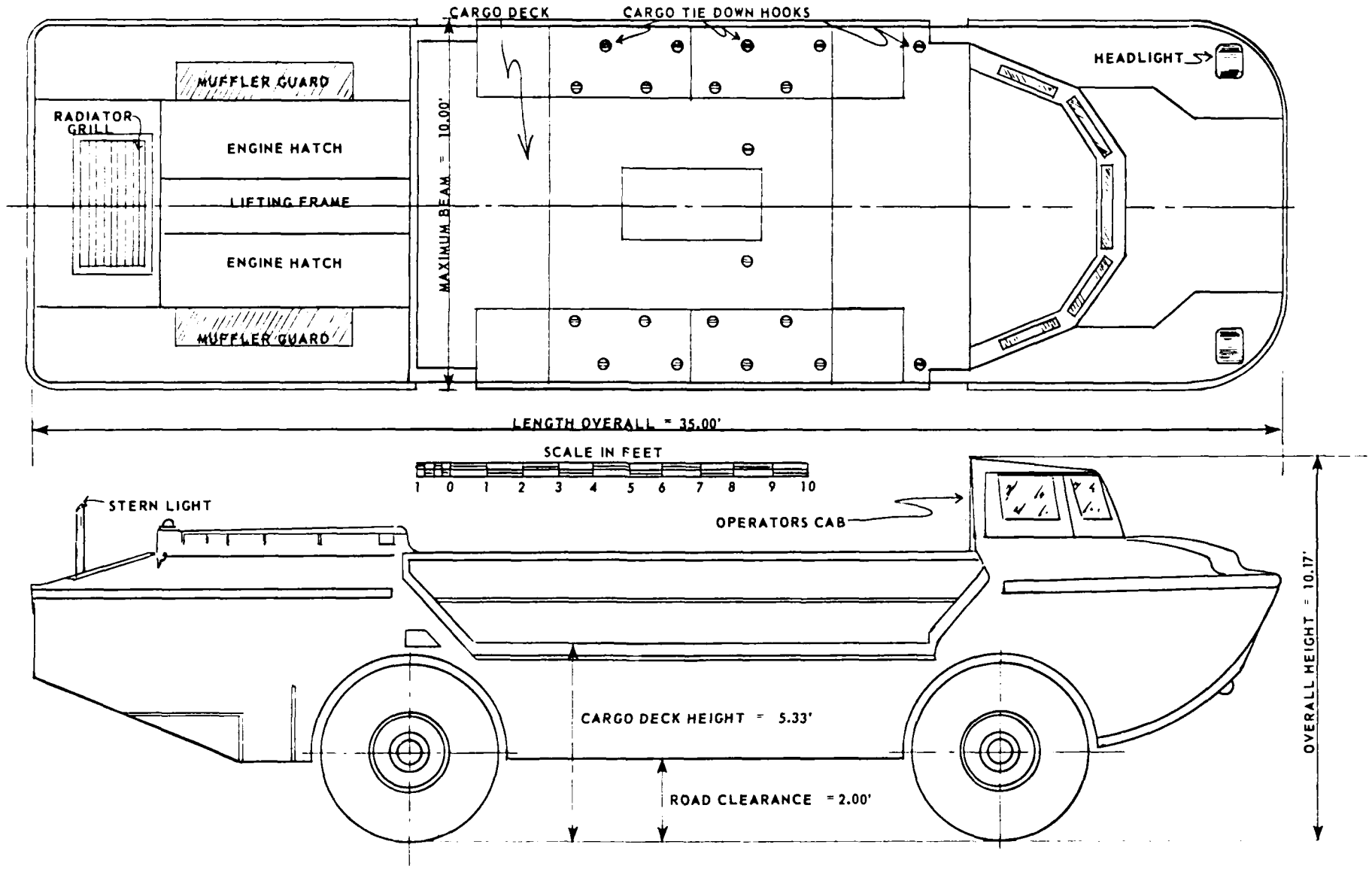
☐ OUTFIT: THE VESSEL REQUIRES A CREW OF TWO PERSONS FOR ITS OPERATION. THE CARGO DECK IS FITTED WITH TEN CARGO TIE DOWN HOOKS AND FOUR LOAD CENTERING DEVICES. THERE ARE TWO HEADLIGHTS LOCATED AT THE FRONT OF THE VEHICLE AND ONE STERN LIGHT. TO PROVIDE ACCESS TO THE ENGINE, THE VEHICLE HAS TWO ENGINE HATCHES, TWO MUFFLER GUARDS, FOUR ENGINE HATCH HANDLES AND ONE LIFTING FRAME. TWO MANUAL BILGE PUMPS ARE INCORPORATED FOR USE IF THE THREE HYDRAULIC BILGE PUMPS FAIL. A MARKER BUOY LOCATES THE LIGHTER IF IT SHOULD SINK IN LESS THAN 100 FEET OF WATER. FOUR 18:00 X 25 TIRES WITH A 12 PLY RATING ARE USED TO SUPPORT THE VEHICLE. PRESSURES OF 9 PSIG AND 18 PSIG ARE RECOMMENDED FOR THE FRONT TIRES FOR SOFT AND HARD TERRAIN RESPECTIVELY WHILE 14 PSIG AND 22 PSIG ARE RECOMMENDED FOR THE REAR TIRES ON SOFT AND HARD TERRAIN RESPECTIVELY. FOUR DRY-CHARGED, TWELVE VOLT, 100 AMPERE HOURS BATTERIES ARE USED. THE TWO FUEL TANKS HAVE A CAPACITY OF 72 GALLONS EACH.

☐ MACHINERY AND PROPULSION: THE ENGINE IS AN INDUSTRIAL GASOLINE ENGINE OF 270 GROSS HORSEPOWER AT 3200 RPM OF WHICH 30 HORSEPOWER IS CONSUMED IN THE AUXILIARY EQUIPMENT LEAVING 240 HORSEPOWER FOR PROPULSION. FOR WATER PROPULSION, A 30 INCH DIAMETER, 30 INCH PITCH PROPELLER IS USED WHICH IS LOCATED IN A HOUSING AT THE REAR OF THE CRAFT WITH A ROAD CLEARANCE OF 1.33 FEET. THE LIGHTER IS CAPABLE OF TRAVELING AT A MAXIMUM SPEED OF 30 MPH ON LAND AND 10 MPH IN THE WATER. THE HIGH RANGE OPERATING RADIUS WITH NO LOAD ON LAND IS 250 MILES AND IS 40 MILES IN WATER. FOR A FULL LOAD, THIS OPERATING RADIUS IS DECREASED TO 200 MILES ON LAND BUT REMAINS 40 MILES IN THE WATER. SPEED LOSS DUE TO WAVE ACTION IS TO BE EXPECTED AND IS DIFFERENT ONLY IN DEGREE BETWEEN THE AMPHIBIAN AND A VESSEL OF SIMILAR DIMENSIONS. FOR THE LARC V SPEED LOSSES COMPARED TO STILL-WATER SPEED AT 225 PROPELLER HORSEPOWER ARE 2% FOR 1.2-LENGTH WAVE, 16% FOR THE 2.0-LENGTH WAVE AND 7% FOR THE 4.0-LENGTH WAVE. THE CRITICAL WAVE LENGTH FOR THE LARC V IS 200 FEET.

☐ MANEUVERING AND CONTROL: THE POWER STEERING SYSTEM ON THE AMPHIBIOUS LIGHTER WILL PERMIT RELATIVELY EASY STEERING. BASICALLY, THE STEERING ON LAND IS ACCOMPLISHED BY FULL HYDRAULIC POWER AND IN WATER BY THE RUDDER. THE TYPE OF TERRAIN (SAND, MUD, OR HARD ROADS) WILL AFFECT LAND STEERING AS WITH ANY AUTOMOTIVE VEHICLE. UNDER IDEAL CONDITIONS SUCH AS HARD SMOOTH SURFACES THE OUTSIDE TURNING RADIUS IS 35.60 FEET WHILE THE INSIDE RADIUS IS 26.50 FEET. THE TURNING RADIUS WILL INCREASE AS THE TERRAIN BECOMES SOFTER. THE LIGHTER IS CAPABLE OF BEING STEERED IF THE HYDRAULIC POWER SHOULD BE LOST BUT MUCH MORE STEERING EFFORT WILL BE REQUIRED; IN WATER THE STEERING WHEEL WILL TURN THE FRONT WHEELS AND THE RUDDER AT ALL TIMES. THE AMPHIBIOUS LIGHTER IS CAPABLE OF GOING UP EXTREMELY STEEP GRADES AS HIGH AS 60%. THE VEHICLES HAVE AN ANGLE OF APPROACH OF 31 DEGREES AND AN ANGLE OF DEPARTURE OF 28 DEGREES.

☐ MISSION SUPPORT: THE ALUMINUM AMPHIBIOUS LIGHTER IS USED TO CARRY CARGO FROM AN OFF-SHORE SUPPLY SHIP TO A BEACH FOR ADVANCED BASE SUPPLY WITH A TOTAL CARGO CAPACITY OF 10,000 POUNDS. IT ALSO SERVES AS A DIVE BOAT OR POWER SUPPLY FOR UNDERWATER WORK. IT ALSO CAN BE USED FOR MOVING PERSONNEL AND EQUIPMENT ACROSS BOTH LAND AND WATER FROM A BASE TO A CONSTRUCTION SITE.

INSHORE OPERATIONS LOGISTICS PLATFORM PHYSICAL AND PERFORMANCE CHARACTERISTICS	LIGHTER, AMPHIBIOUS, RESUPPLY, CARGO: LARC V



INSHORE OPERATIONS LOGISTICS PLATFORM OVERALL GEOMETRY	LIGHTER, AMPHIBIOUS, RESUPPLY, CARGO: LARC V

☐ GEOMETRY: THE BOSTON WHALER IS A FIBERGLASS BOAT WHOSE CONSTRUCTION UTILIZES A STRUCTURAL FOAM CORE FOR HULL INTEGRITY AND RIGIDITY. THERE ARE PRESENTLY TEN DIFFERENT MODELS OF BOSTON WHALERS BEING BUILT, WITH OVERALL LENGTHS RANGING FROM 9'2" TO 21'4". THE MAXIMUM BEAM RANGES FROM 4'4" TO 7'4". THE OUTRAGE 19, TYPICAL OF THE BOSTON WHALER SERIES, IS USED ON THE FOLLOWING PAGE TO ILLUSTRATE THE OVERALL GEOMETRY OF THESE PLATFORMS.

☐ HYDROSTATICS: THESE BOATS, WHICH HAVE A HIGH STRENGTH-TO-WEIGHT RATIO, RANGE IN WEIGHT FROM 125 LBS. TO 1800 LBS.

☐ STRUCTURE: THE RESULT OF THE SANDWICH METHOD OF CONSTRUCTION IS A BOAT WITH GREAT HULL STRENGTH AND FLOTATION. IT PROVIDES A RIGID FOAM CORE THAT IS STABLE, INCREASING THE LIFE OF THE BOAT. FOAM COMPLETELY FILLS THE SPACE BETWEEN THE INSIDE AND OUTSIDE HULLS AND WELDS ITSELF TO THE FIBERGLASS SKINS TO FORM A RUGGED ONE-PIECE UNIT. THE FIBERGLASS SKIN IS SUPPORTED OVER ITS ENTIRE SURFACE INCREASING THE HULL'S RIGIDITY AND STRENGTH.

☐ SEAWORTHINESS: BOSTON WHALER HULLS HAVE BEEN DESIGNED WITH SEAWORTHINESS AS A PRIME OBJECTIVE. THE FORWARD HULL SPONSONS GIVE THE BOAT STABILITY AT REST. THE SAME SPONSONS DIG IN WHEN THE BOAT IS BEING PUSHED BY A FOLLOWING SEA, EXPOSING, IN EFFECT, THREE KEELS TO THE WATER. THE BLUNT, FULL BOW SECTIONS OF BOSTON WHALERS GIVE EXTRA BUOYANCY WHEN PLUNGING INTO HEAVY SEAS. THE COMBINATION OF THE HIGH FOAM VOLUME AND THE LOW FREEBOARD GIVES BOSTON WHALERS A GREAT SAFETY MARGIN SHOULD A BOAT BE DAMAGED OR SWAMPED. THE HIGH FOAM VOLUME ENSURES FLOTATION EVEN IN THE WORST CONCEIVABLE CIRCUMSTANCES. THE LOW FREEBOARD POSITIONS THE ENGINE POWER HEAD ABOVE GUNWALE LEVEL AND THEREFORE ALWAYS ABOVE WATER AND CAPABLE OF BEING RUN. THE LOW FREEBOARD NOT ONLY CONTRIBUTES TO SAFETY BUT ALSO MAKES THE BOATS MORE FUNCTIONAL AS PLATFORMS AS THEY ARE LESS AFFECTED BY CROSSWINDS MAKING THEM EASIER TO MANEUVER IN STRONG WINDS.

SPECIFICATIONS

MODEL	DIMENSION A	BEAM	WEIGHT (LB.)	MAXIMUM HORSEPOWER	MINIMUM HORSEPOWER	SWAMPED BUOYANCY
SQUALL 9'	9'2"	4'4"	125	3	-	600 LBS.
STANDARD 11'	11'4"	5'0"	210	10	-	750 LBS.
SPORT 11'	11'4"	5'0"	220	20	-	750 LBS.
SPORT 13'	13'4"	5'5"	300	40	9.5	950 LBS.
SPORT 15'	15'3"	5'8"	450-500	75	25	1650 LBS.
SPORT 17'	16'7"	6'2"	650-850	100	40	2000 LBS.
SAKONNET/MONTAUK 17'	16'7"	6'2"	770-900	100	40	2000 LBS.
BASS BOAT/NEWPORT 17'	16'7"	6'2"	950	100	40	2000 LBS.
OUTRAGE/REVENGE 19'	19'4"	7'4"	1500-1600	170	65	4000 LBS.
OUTRAGE/REVENGE 21'	21'4"	7'4"	1600-1800	200	65	3700 LBS.

INSHORE OPERATIONS LOGISTICS PLATFORM
PHYSICAL CHARACTERISTICS

TYPICAL BOSTON WHALERS

☐ OUTFIT: EACH COMPONENT THAT IS ADDED TO THE HULL STRUCTURE OF THE BOSTON WHALER IS DESIGNED TO PERFORM A SPECIFIC FUNCTION. THE RAILS, MADE OF STAINLESS STEEL, ARE FAR STRONGER AND MORE RESISTANT TO CORROSION THAN NORMAL ALUMINUM RAILS. THE BOW RAILS ARE HIGH TO PROVIDE SECURITY AND SAFETY FOR THE BOATS' OCCUPANTS. FOR MAXIMUM RIGIDITY AND LEVERAGE THE RAILS ARE SECURED WITH TWO STANCHION SUPPORTS, ONE HIGH AND ONE LOW. THE BOW CHOCKS, MADE OF CAST BRONZE, ARE DESIGNED TO PREVENT RUB RAIL WEAR. HEAVY DUTY RUB RAILS ARE SECURELY FIXED TO THE HULL AND HAVE AN INSERT WHICH IS EASILY RENEWED IF NECESSARY. OUTRIGGERS ON THE 16's, 19's, AND 21's ARE MOUNTED ON THE CONSOLE RAIL IN SPECIALLY DESIGNED ALUMINUM CASTINGS. STERN LIGHTS ON THE 19- AND 21-FOOT BOATS ARE SIX FEET ABOVE THE FLOOR AND HAVE AN ANTI-GLARE SHIELD FOR NIGHT WORK. SEATING OPTIONS MAY BE INSTALLED IN MANY OF THE 17-, 19-, AND 21-FOOT MODELS BECAUSE OF THEIR SPACIOUS INTERIORS. THE OPTIONS ADD TO THE VERSATILITY OF THE BOAT AND ENABLE THE OPERATOR TO CUSTOM RIG THE BOAT FOR HIS NEEDS. FIVE OF THE COMMON OPTIONS INCLUDE UPHOLSTERED SWIVEL SEAT, REVERSIBLE PILOT SEAT, 4 MAN SEAT, REVENGE STORAGE SEAT, AND COOLER SEATS.

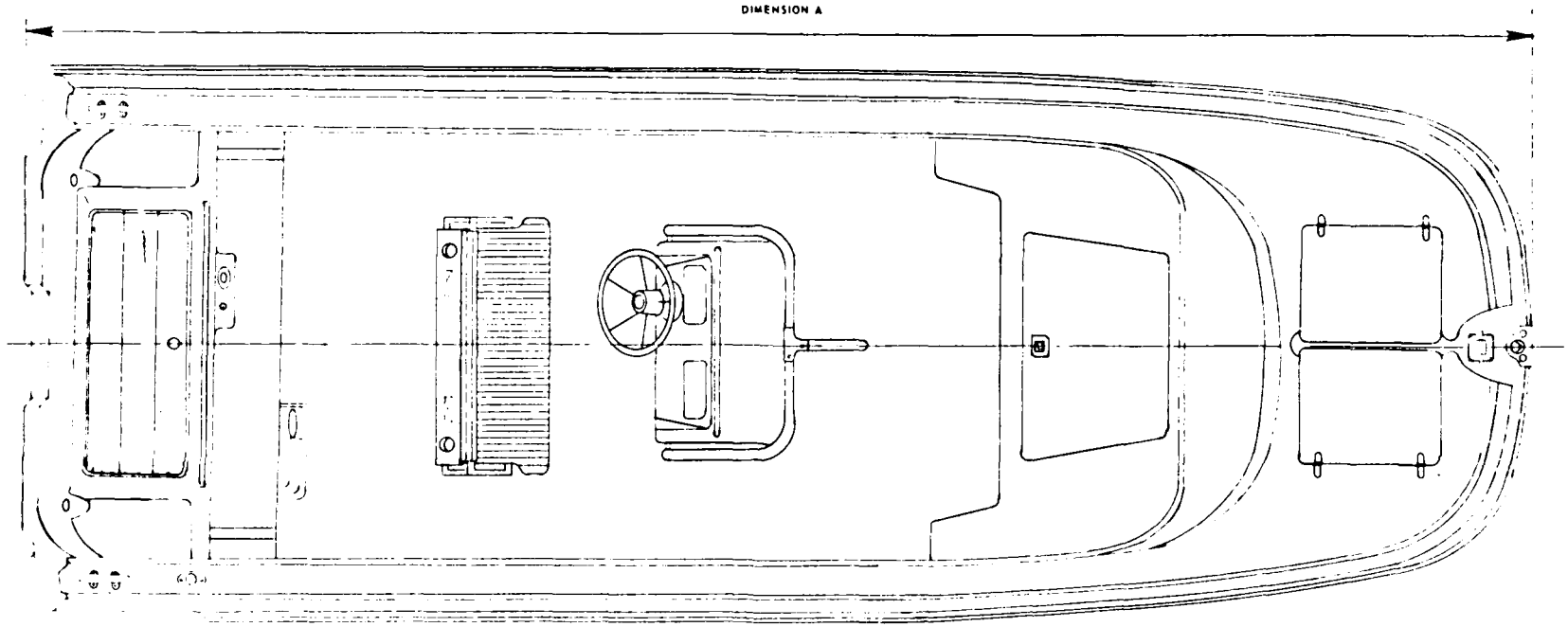
☐ MACHINERY AND PROPULSION: THE BOSTON WHALER SERIES CAN BE PROPELLED THROUGH THE WATER WITH A VARIETY OF ENGINES RANGING IN POWER FROM A SINGLE 10 HORSEPOWER ENGINE ON THE 13-FOOT MODEL TO TWIN 85-HORSEPOWER ENGINES ON THE 19- AND 21-FOOT OUTRAGE MODELS FOR A COMBINED TOTAL POWER OF 170 HORSES. THE RANGE OF SPEEDS FOR THE SERIES IS FROM 18 MPH WITH A 13-FOOT BOAT TO A TOP SPEED OF 44 MPH WITH A 19-FOOT OUTRAGE. THE AVERAGE SPEED FOR THE SERIES IS BETWEEN 30 AND 35 MPH. THE TABLES BELOW GIVE SPEEDS WHICH ARE APPROXIMATE AND CAN VARY WITH MAKE AND CONDITION OF ENGINE, WIND AND WATER CONDITIONS, AND BOAT DISPLACEMENT.

SINGLE ENGINE PERFORMANCE IN MILES PER HOUR

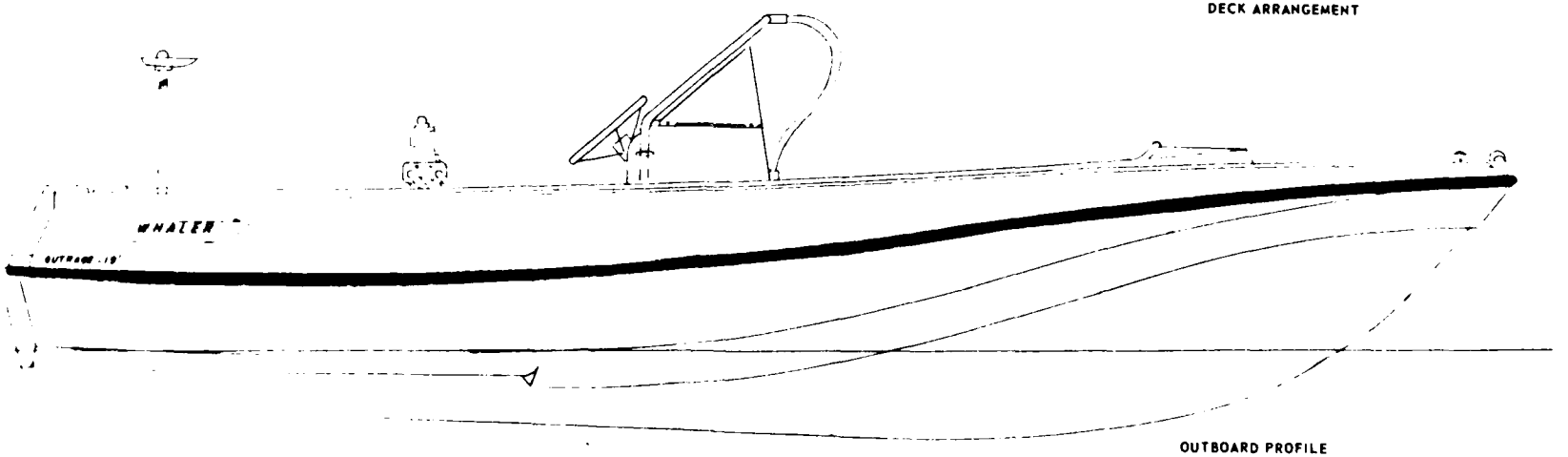
HORSEPOWER	10	20	40	50	65	85	115	135	150
13'4"	18	25	36						
16'7"			26	30	34	38			
19'4" OUTRAGE					30	34	40	42	44
21'4" OUTRAGE					28	32	36	40	42
19'4" REVENGE						30	34	37	38
21'4" REVENGE						28	32	35	36

DUAL ENGINES PERFORMANCE IN MILES PER HOUR

HORSEPOWER	2-40'S	2-50'S	2-65'S	2-85'S
19'4" OUTRAGE	30	34	38	44
21'4" OUTRAGE	28	32	36	42



DECK ARRANGEMENT



OUTBOARD PROFILE

INSHORE OPERATIONS LOGISTICS PLATFORM OVERALL GEOMETRY	TYPICAL BOSTON WHALER

APPENDIX E

WEATHER, TIDE, AND CURRENT CONDITIONS AT THE INSTALLATION SITES

RELEVANT GEOGRAPHICAL AND ENVIRONMENTAL
INFORMATION EXCERPTED FROM UNITED STATES
COAST PILOT 7, PACIFIC COAST, CALIFORNIA,
OREGON, WASHINGTON, AND HAWAII
ELEVENTH EDITION - JUNE 1975

TIDE TABLES 1976 - HIGH AND LOW WATER PREDICTIONS

TIDAL CURRENT TABLES 1976 - SLACK WATER AND MAXIMUM CURRENT VELOCITIES

Queets River is the largest stream between Grays Harbor and Cape Flattery. The S point is a low, sandy spit about 0.1 mile long, projecting from an abrupt cliff, 80 feet high, and densely wooded. The N point is 1.3 miles long, low, and sandy, with some trees at the mouth of the river, and a narrow lagoon between it and the bluff.

From Queets River for 10 miles to abreast Destruction Island, the coast is rather low and is broken by cliffs about 50 feet high with broad low-water beaches. **Kalaloch Rocks** lie about 4.5 miles N of the river, close inshore.

Destruction Island, 90 feet high, is 20 miles NNW of Cape Elizabeth and 3 miles offshore. It is flat-topped and covered with brush, with a few clumps of trees. The island is 0.5 mile long and 300 yards wide at its S part. From the N end rocks and ledges extend about a mile from the cliffs; these are bordered by a line of kelp on the inshore side.

Destruction Island Light (47°40.5'N., 124°29.1'W.), 147 feet above the water, is shown from a 94-foot white conical tower with black gallery on the SW part of the island; a fog signal is at the light.

An indifferent anchorage, affording shelter from NW winds, may be had off the SE face of the island in 10 fathoms, sandy bottom, with the light bearing between **293°** and **315°**. Vessels must leave if the wind hauls W or S. During the fishing season many small fishing boats anchor for the night under Destruction Island; it is the only shelter from offshore winds between Grays Harbor and Cape Flattery.

Chart 18480 (6102).-For 5.5 miles from Destruction Island to Hoh Head, the coast trends in a general NW direction. The cliffs are 50 to 100 feet high, and many rocks and ledges extend 1.2 miles offshore in some places.

Abbey Islet, 3.5 miles NE of Destruction Island, is over 100 feet high and covered with trees. It is 200 yards off the cliffs. Many rocks lie close S of it, the most distant of which is **South Rock,** 46 feet high, 1 mile S, and 0.5 mile offshore.

At the mouth of **Hoh River,** 2 miles SE of Hoh Head, is a broad sand beach; the absence of cliffs for 0.5 mile is noticeable for a considerable distance offshore. In smooth weather the river can be entered by canoes, but the channel shifts. An Indian village is on the S bank at its mouth.

Hoh Head, 200 feet high, is a bright yellow cliff covered with a dense forest. It projects a little over 0.5 mile from the general trend of the coast. A large cluster of rocks is off the S cliff of the head and covered rocks extend to about 1.6 miles offshore between the head and North Rock. A rock covered 2¼ fathoms lies 1.8 miles WNW of Hoh Head.

Middle Rock, North Rock, and **Perkins Reef** are other dangers within 1.5 miles off Hoh Head. Middle Rock, 65 feet high and black with vertical sides, is 0.8 mile off the mouth of Hoh River. North Rock, a mile S of Hoh Head, is 107 feet high and grayish in color, with steep sides; in the afternoon sun this rock shows white, which makes it a very distinct landmark. Perkins Reef is a long, bold, and jagged islet, 1.1 miles W of Hoh Head. This area has numerous other rocks, covered and bare.

The coast continues rugged and rocky from Hoh Head to La Push, 11 miles to the NW. The cliffs are 100 to 120 feet high, broken here and there by small streams. Several rocky islets 25 to 120 feet high and covered ledges extend in some places as much as 2 miles offshore.

Alexander Island, 121 feet high, is 2 miles NNW of Hoh Head and a mile offshore. It is covered with low vegetation, and is flat-topped with steep sides. The island is prominent in hazy or smoky weather. A covered rock, 1.8 miles WNW of Alexander Island, is the outermost known danger in this vicinity.

Toleak Point, 4.7 miles NW of Hoh Head, is a narrow point terminating in a small knob with an abrupt seaward face. A high wooded islet lies 400 yards W of the point, to which it is connected by an extensive bare reef. **Rounded Islet,** a grassy rock 130 feet high with steep sides, is 0.3 mile seaward of Toleak Point. A low black rock is 0.7 mile S of the islet.

Giants Graveyard, 1.5 miles N of Toleak Point, consists of very irregular rocks; the largest are up to 210 feet high. The farthest offlying rock is about 0.8 mile from shore.

Teahwhit Head, 8 miles NW of Hoh Head and 2.4 miles SSE of La Push, is a jagged double point 100 feet high and heavily wooded. **Strawberry Bay,** on the SE side of the head, is a small bight in which fishing boats find shelter from NW winds. There are numerous rocks in and around the bight.

Quillayute Needle, 81 feet high, 1.3 miles WNW of Teahwhit Head, is the outermost of many rocks, visible or covered, that lie within a mile of the shore. Some are as high as 100 to 195 feet, and many are awash or covered by a fathom or less. The foul area continues to James Island, at the entrance to La Push.

James Island, 15 miles NNW of Destruction Island on the N side of Quillayute River mouth, is 183 feet high, bold and wooded, and joined to the beach at low water. Numerous smaller wooded islands, immediately N, are prominent. An indifferent anchorage affording some shelter from NW winds may be had close SE of James Island, in 5 to 6 fathoms, sandy bottom, about 600 yards from the beach. Sea swell makes this anchorage unsafe.

James Island Light (47°54.3'N., 124°38.8'W.), 150 feet above the water, is shown from a white house on the S part of the island. A radiobeacon and fog signal are at the light.

La Push, an Indian village on the E bank and about 0.4 mile above the entrance of **Quillayute River,** is an important sport fishing center. The river channel is protected by a jetty on the SE side and a dike on the NW side; a lighted whistle buoy is about 1.8 miles SW from the outer end of the jetty.

The river channel leads from the sea to a small-craft basin at La Push. In 1972, the controlling depth was 10 feet to the entrance of the basin; depths of about 10 feet were reported available in the basin in 1973. The N and S sides of the entrance to the basin are marked by lights. A power cable with a clearance of about 100 feet crosses the river near its mouth.

The channel, which passes close to the SE shore of James Island, is sometimes dangerous, especially in heavy S weather. Weather conditions which make the entrance hazardous normally occur only in the winters, usually in December and January. When there are breakers of any size making across the entrance, it should not be attempted except at better than half tide and with a well-powered boat. Strangers may request assistance from the La Push Coast Guard station by radio or signals; a Coast Guard boat will lead the vessel in if practicable. The tank at the Coast Guard station is prominent.

Weather.–Maritime air from over the Pacific has an influence on the climate throughout the year. In the late fall and winter, the low-pressure center in the Gulf of Alaska intensifies and is of major importance in controlling weather systems entering the Pacific Northwest. At this season of the year, storm systems crossing the Pacific follow a more S path striking the coast at frequent intervals. The prevailing flow of air is from the SW and W. Air reaching this area is moist and near the temperature of the ocean water along the coast which ranges from 45° F. in February to 57° F. in August. The wet season begins in late September to October. From October through January, rain may be expected on about 26 days per month; from February through March, on 20 days; from April to June, on 15 days; and from July to September, on 10 days. As the weather systems move inland, rainfall is usually of moderate intensity and continuous, rather than heavy downpours for brief periods. Gale force winds are not unusual. Most of the winter precipitation over the coastal plains falls as rain; however, snow can be expected each year. Snow is seldom deeper than 10 inches or remains on the ground longer than 2 weeks. Annual precipitation increases from about 90 inches near the coast, to more than 120 inches over the coastal plains, to 200 inches or more on the wettest slopes of the Olympic Mountains.

During the rainy season, temperatures show little diurnal or day to day change. Maximums are in the forties or minimums in the mid-thirties. A few brief outbreaks of cold air from the interior of Canada can be expected each winter. Clear, dry, cold weather generally prevails during periods of E winds. Maximum temperatures range from 25°F. to 35°F. and minimums from 10°F. to 25°F.

In the late spring and summer, a clockwise circulation of air around the large high-pressure center over the North Pacific brings a prevailing NW and W flow of cool, comparatively dry, stable air into the NW Olympic Peninsula. The dry season begins in May with the driest period between mid-July and mid-August. The total rainfall for July is less than 0.5 of an inch in 1 summer out of 10; also, it exceeds 5.0 inches in 1 summer out of 10. During the warmest months, afternoon temperatures are in the upper sixties and lower seventies, reaching the upper seventies and the lower eighties on a few days. Occasionally, hot, dry air from the E of the Cascade Mountains reaches this area and maximum temperatures are in the mid- or upper-nineties for 1 to 3 days. Minimum temperatures are in the upper forties and the lower fifties. The lowest relative humidity and greatest danger of forest fires occur with E winds.

In summer and early fall, fog or low clouds form over the ocean and frequently move inland at

night, but generally disappear by midday. In winter, under the influence of a surface high-pressure system, centered off the coast, fog, low clouds, and drizzle occur daily as long as this type of pressure pattern continues. The average frost-free season is from the last of April until mid-October.

The National Weather Service maintains an office at the Quillayute Airport about 3 miles inland from the coast; barometers may be compared here. **Storm warning display** locations are listed on NOS charts and shown on the Marine Weather Services Charts published by the National Weather Service. (See page T-5 for Quillayute climatological table.)

The Coast Guard has established a **rough bar advisory sign**, 34 feet above the water, visible from the channel looking seaward, on the NW corner of the Coast Guard boathouse, to promote safety for small-boat operators. The sign is diamond shaped, painted white with an international orange border, and with the words "Rough Bar" in black letters. The sign is equipped with two alternating flashing amber lights. The lights will be activated when seas exceed 4 feet in height and are considered hazardous for small boats. Boatmen are cautioned, however, that if the lights are not flashing, it is no guarantee that sea conditions are favorable.

About 350 berths, electricity, gasoline, diesel fuel, water, ice, a launching ramp, and some marine supplies are available at the basin at La Push. A 3-ton hoist can handle craft to 24 feet; however, no repairs can be made at the basin. A good highway connects La Push with U. S. Highway 101 N of Forks.

From James Island NNW for 16.4 miles to Cape Alava, the rugged coast continues, with rocks and foul ground extending as much as 2 miles offshore; the land side consists of steep wooded bluffs and narrow beaches. The cliffs, however, are not continuous. The once densely timbered country ascends gradually E to the snow-capped mountains of the Olympic Range, which can be seen for many miles in clear weather. In 1974, areas of heavy logging activity were in evidence inland for many miles from this coastal area.

Cake Rock, 116 feet high, is 2 miles NW of James Island and 1.5 miles offshore. This rock, about 200 yards long, has steep sides and its flat top is surmounted by a 20-foot mound. There are several other visible rocks between Cake Rock and the shore.

Cape Johnson, small and not particularly prominent, projects less than 0.5 mile from the coastline, terminating in a vertical cliff 100 feet high.

Jagged Islet, 78 feet high, 2.6 miles NW of Cape Johnson, is large, brown, covered with guano, and irregular in outline. A low black rock lies 200 yards N. **Carroll Islet**, 225 feet high, is 0.8 mile N of Jagged Islet. It has vertical whitish sides and wooded top. A pillar rock, 134 feet high, lies 200 yards W, and a low black rock is 200 yards off the SE side. Carroll Islet and the pillar rock are quite prominent, especially in the sunlight.

Bald Islets are two high, bare rocks inside of Jagged and Carroll Islets about 0.8 mile offshore. The outer and larger one is 320 feet high with steep sides, and the smaller is 183 feet high. They are 200 yards apart, and between them are two pinnacle rocks close together. Many other rocks are shoreward of the islets.

Hand Rock, 33 feet high, is 1.5 miles N of Carroll Islet and 1.5 miles offshore. So named from its shape, the rock is black with a white cap of guano on top.

White Rock, 161 feet high, 1.7 miles S of Cape Alava and about 0.8 mile offshore, has nearly vertical sides and a rounded top; it is whitish, and in the sunlight is visible for a long distance. A group of large, low, black rocks lie 0.8 mile SSE of White Rock and 0.8 mile offshore. A rock covered 6 fathoms is 2.2 miles W of White Rock.

Chart 18485 (6265).-Cape Alava, the westernmost point of the State of Washington, is 13 miles S of Cape Flattery. The seaward face is about 0.6 mile in extent. **Iskawahyah Island**, a steep rocky island, 142 feet high and with trees on top, is off its NW extremity. The shore is bordered by numerous rocks and covered ledges.

The several fixed lights along this otherwise remote stretch of shoreline are associated with the year-round operation of the Ozette Archaeological Expedition which was established at an abandoned Indian village site on Cape Alva in 1970.

Flattery Rocks and **Umatilla Reef** are rocks and islets extending W from Cape Alava for 2.3 miles. **Ozette Island**, 236 feet high, is 0.8 mile SW of the cape. The island, 0.5 mile long, is flat-topped with steep sides. About 0.3 mile off the S and SE sides are low, black rocks. **Bodelteh Islands**, 1.2 miles WNW of the N end of Cape Alava, have high bold seaward faces. The outer one is 198 feet high.

In season, a few fishermen find shelter in an anchorage off the SE end of Ozette Island. The area is small and requires local knowledge to enter. It affords fair protection from the prevailing NW wind.

Umatilla Reef, 2.3 miles NW of Cape Alava, the greatest danger to navigation off the N coast, lies 0.7 mile W of the outer Bodelteh Island. It extends for 200 yards in a W direction and is about 75 yards wide. The reef consists of small, low, black rocks and some breakers. There is a reported breaker 1.1 miles NNE of this reef, and a rock covered 3 feet, 0.3 mile E of the reef, which endangers the passage inside Umatilla Reef, sometimes used by small boats. Umatilla Reef is difficult to make out, especially in thick weather. A lighted whistle buoy is 1.8 miles NW, and a lighted horn buoy is 1.7 miles WSW of the reef.

Between Cape Alava and Cape Flattery, the coast curves slightly in a series of bights, but continues as rugged as before. There are alternate

stretches of wooded bluffs and high rocky cliffs. The country immediately back of the beach is not high, but it is densely wooded.

Point of the Arches, 5 miles NNW of Cape Alava, is the N point of the cliffs that extend some 1.5 miles S. Numerous rocks and ledges are offshore as far as about a mile.

Father and Son, two rocks connected by a low reef, lie 0.6 mile offshore abreast the S end of the cliffs. The outer rock is 167 feet high, and the inner one 65 feet high. From the outer rock to Spike Rock there are several exposed rocks.

Spike Rock, 35 feet high, sharp and bare, is 0.8 mile NW of the Point of the Arches. It is the outermost of a chain of rocks, the largest of which is 185 feet high; there are three arches in these rocks. A rock that uncovers 5 feet is 0.3 mile WSW of Spike Rock.

Portage Head, 2.5 miles N of Point of the Arches, has a mile-long seaward face of bold irregular cliffs over 410 feet high. A reef extends from the point toward Cape Flattery for 1.5 miles showing several low, black rocks awash, and one small rock 45 feet high. A rock that uncovers is 1.3 miles NW of Portage Head.

Mukkaw Bay is a shallow bight included between Portage Head and Waatch Point. It affords indifferent shelter in N and E weather and a smooth sea, but is little used. During salmon runs many native pulling boats beach here at night. The shores are low and sandy. **Waatch River** enters in the N part of the bight immediately E of Waatch Point. It is a tidal slough, and the valley through which it runs extends about 2 miles to Neah Bay on the Strait of Juan de Fuca. This low depression is one of the features for recognizing Cape Flattery.

Waatch Point, 3 miles SE of Cape Flattery, is the SE extremity of the cliffs extending to the cape. This stretch is bordered by numerous rocks and ledges.

Fuca Pillar, 0.2 mile S of the W point of Cape Flattery, is a rocky column 157 feet high and 60 feet in diameter, leaning slightly NW. It is 150 yards off the face of the cliff, and is more prominent from N than from S.

Cape Flattery, a bold, rocky head with cliffs 120 feet high, rises to nearly 1,500 feet about 2 miles back from the beach. From S it looks like an island because of the low land in the valley of Waatch River. Numerous rocks and reefs border the cliffs E and S of the cape. Tide rips are particularly heavy off Cape Flattery.

Tatoosh Island, 0.4 mile NW of Cape Flattery, is about 0.2 mile in diameter, 108 feet high, flat-topped, and bare. It is the largest of the group of rocks and reefs making out 0.4 mile W. The passage between Tatoosh Island and the cape is dangerous and constricted by two rocks awash near its center. Although sometimes used by local small craft, it cannot be recommended. The currents are strong and treacherous.

(See page T-5 for **Tatoosh Island climatological table.**)

Cape Flattery Light (48°23.5′N., 124°44.1′W.), 165 feet above the water, is shown from a 65-foot white conical tower on a sandstone dwelling on the W end of Tatoosh Island. A radiobeacon and fog signal are at the light.

A rocky patch, covered 7½ fathoms, on which the sea breaks occasionally in a W swell, is 1.4 miles SW of the light.

Duncan Rock and **Duntze Rock,** the two principal dangers NNW of Tatoosh Island, lie respectively, 1 mile and 1.3 miles from the light. Duncan Rock is small, low, and black; Duntze Rock is covered 3¾ fathoms. A lighted whistle buoy is 500 yards NW of Duntze Rock. Ledges and rocks constrict the passage between Duncan Rock and Tatoosh Island to less than 0.5 mile, and strong currents and tide rips make it hazardous.

Chart 18480 (6102).-Swiftsure Bank, about 3.5 miles in extent, lies off the mouth of the Strait of Juan de Fuca, NW of the submarine valley making into the strait. The bank has a least depth of 19 fathoms.

During the summer, large numbers of fishing vessels may be trolling or at anchor on Swiftsure Bank. During periods of low visibility, which are not uncommon in this vicinity, extreme caution must be exercised to avoid collision with fishing boats; most of these craft tend to defy radar detection.

The Canadian Armed Forces have established a **firing practice and exercise area** in the approach to the Strait of Juan de Fuca, about 20 miles W of Cape Flattery. Vessels should exercise caution when navigating in this vicinity while exercises are in progress.

Carmanah Point to Amphitrite Point, Canada.-The coast from Carmanah Point to Cape Beale is very dangerous and, except during fine weather and offshore winds, should be given a wide berth.

Carmanah Point is on the Vancouver Island shore, 13 miles N of Tatoosh Island. A light, 175 feet above the water, is shown from a white octagonal concrete tower on the point; a fog signal and radiobeacon are at the light.

Clo-oose, a small village and mission, is 4 miles NW of Carmanah Point in the small cove at the mouth of the Cheewhat River, E of the entrance to Nitinat Lake.

A reef 0.8 mile long in a NW direction, with a rock awash in its center, is off this cove. It is marked by a lighted whistle buoy 0.8 mile SW of the rock.

Tsusiat Lake is 8.5 miles NW of Carmanah Light. At the seaward end of the lake is a conspicuous waterfall which is visible far off even in hazy weather, and may help fix a vessel's position as it is the only waterfall on this part of the coast. Behind Tsusiat Lake the mountains rise to more than 2,000 feet.

Pachena Point, 25 miles NW of Cape Flattery, is marked by a light; a fog signal is at the light.

Seabird Rocks are off the entrance to Pachena Bay, 3 miles NW of Pachena Point. The largest is about 48 feet high, bare, and of small extent; it is marked by a light. There is no safe passage between Seabird Rocks and the shores NE, and the rocks should not be approached closer than 1.5 miles.

Cape Beale is a bold rocky point, 120 feet high. A reef with rocks above and below water extends about 0.8 mile SW from it. A light, 170 feet above the water, is shown from a white slatted daymark on a red square skeleton tower near the W extremity of the cape; a fog signal and a marker radiobeacon are at the light.

Barkley Sound, an extensive arm of the sea 35 miles NW of Cape Flattery, lies between Cape Beale and Amphitrite Point. It is 15 miles wide at its entrance, and though encumbered by numerous islands and rocks, it maintains a breadth of 13 miles for 8 miles inland, above which it separates into several narrow inlets. The shores are low, except in the N part and among the inlets, where they become high, rugged, and mountainous.

In the W part of the sound are innumerable rocks and islands with navigable channels between them. Entrance should not be attempted without local knowledge or a pilot. Imperial Eagle Channel is the easiest of access.

Amphitrite Point is the W entrance point of Barkley Sound. A light, 58 feet above the water, is shown from a white rectangular tower on the end of the point; a radiobeacon and fog signal are at the light. A whistle buoy is 0.6 mile S of the point.

A more detailed description of Canadian waters is given in Pub. No. 154, Sailing Directions (Enroute) for British Columbia, published by the Defense Mapping Agency Hydrographic Center, and the Sailing Directions, British Columbia Coast, (South Portion) Vol. I, published by the Canadian Hydrographic Service.

Routes.-In clear weather no difficulty will be experienced in approaching the entrance to the Strait of Juan de Fuca from any direction, as the land on both sides is high and Cape Flattery is readily distinguished, particularly from S, owing to the low land between Mukkaw and Neah Bays. Lights, fog signals, and radiobeacons are available on both sides of the strait to assist in obtaining a fix.

In thick weather soundings will assist in estimating the distance from shore. Vessels should pick up the 100-fathom curve and be guided by the soundings. The relationship between the 100- and 50-fathom curve is a good indication for fixing the position; vessels should not proceed inside the 50-fathom curve until a fix has been obtained. The mountain peaks in the interior sometimes can be seen when the coast is obscured by fog.

Depths.-The depths in the approaches to the Strait of Juan de Fuca are very irregular, especially outside the 50-fathom curve. There is a deep submarine valley with depths of over 100 fathoms and a width of 2 to 4 miles, between the 100-fathom curves, which leads from about 37 miles SSW of Cape Flattery, rounds this cape at a distance of 2 miles, and extends about 32 miles into the strait. The 100-fathom curve on the W side of this submarine valley is very irregular, but on the E side it is more regular. Within the strait the curve is regular on both sides of the valley.

Currents.-The currents on Swiftsure Bank and at Umatilla Reef are described in the Tidal Current Tables. Off the entrance of the Strait of Juan de Fuca the coastal current is influenced by the flow into and out of the strait. On the flood there is a set into all the sounds on the Vancouver Island shore, and this, combined with the prevailing NW current and light S winds, with possibly some swell from the same direction, makes the coast in the vicinity and W of Carmanah Light dangerous, especially for small vessels. Many strandings have occurred on the Vancouver Island shore.

The flood current entering the Strait of Juan de Fuca sets with considerable velocity over Duncan and Duntze Rocks, but instead of running in the direction of the channel there is a continued set toward the Vancouver Island shore, which is experienced as far as Race Rocks. The flood current also has more velocity on the N shore of the strait than on the S.

The ebb current is felt most along the S shore of the strait, and between New Dungeness Light and Crescent Bay there is a decided set S and W, especially during large tides. With wind and swell against the current, a short choppy sea is raised near the entrance to the strait. (For additional information on currents in the Strait of Juan de Fuca, see chapter 12.)

Sailing craft approaching the strait should keep well off the mainland coast S of Cape Flattery, unless working to windward against a fine N wind, which is frequently found during the summer. In this case the coast may be approached to within 3 miles. At other times there is no inducement to hug the coast, on which a long rolling swell frequently sets, and this swell, meeting the SE gales of winter, causes a confused sea. The cape and its offlying dangers should be given a berth of at least 3 miles, as the tidal current sometimes sets with great velocity toward Duncan and Duntze Rocks. It is equally necessary when entering or leaving the strait to avoid the coast of Vancouver Island between Port San Juan and Bonilla Point, when there is any appearance of bad weather.

Sailing vessels making the strait during the winter, especially during November and December, and experiencing the E and SE winds prevalent at that season, should endeavor to hold a position S or SW of Cape Flattery, and should on no account open the entrance of the strait until an opportunity offers of getting well inside. It is also important to remember that, though it may be blowing strongly from the S or SSW outside, on rounding Cape Flattery, an E wind may be found blowing out of the strait, and a vessel would then

find the Vancouver Island coast a dangerous lee shore.

Coming from the W with a heavy W or NW gale and thick weather, vessels uncertain of their positions should lie-to on soundings at not less than 30 miles from the entrance or on the edge of the bank. These gales seldom last more than 12 hours, and if they veer toward the SW the weather will clear and vessels may bear up for the strait.

Fog.-The fog is generally heavier near the entrance, decreasing in density and frequency up the strait. Near the entrance the fog sometimes stands like a wall, and vessels entering the strait run out of it into clear bright weather, even before passing Tatoosh Island. The fog frequently extends a long distance seaward and, when combined with the smoke from forest fires, becomes exceptionally dense. The wind gradually works the fog into the strait, and it will follow the N shore past Port San Juan to the Sombrio River; occasionally it will reach as far as Sooke Inlet and at times to Race Rocks. As a rule, however, the fog moves farther into the strait along the S shore, at times reaching Port Townsend; frequently the N shore is clear when the S shore is enveloped in fog.

During the spring, fog is frequent in the strait. With the W wind it often stops at the headland between Crescent and Freshwater Bays, the fog then extending W while it is clear to E. When fog extends past Freshwater Bay the small area about the W bight will often be clear.

Weather.-In summer, the prevailing NW winds draw into the strait, increasing toward evening and at times blowing a 10-knot breeze before midnight. This occurs, however, only when the winds are strong outside. In light winds, sailing vessels may be a week from Cape Flattery to Admiralty Inlet, and vice versa.

In winter, SE winds draw out of the strait, causing a confused cross-sea off the entrance, the heavy SW swell meeting that coming out. Under these conditions small outboard vessels, especially sail, often make Neah or Clallam Bays and await more favorable weather. The weather off the entrance as a rule is exceptionally severe, and wrecks are of frequent occurrence. The heavy broken seas are probably due to the shoaling off the entrance, the irregularity and velocity of the currents, and the conflict between the wind drawing out of the strait and that along the outer coast.

The rainfall in the vicinity of the entrance is considerable, even during the summer, although the heaviest rains occur between December and March.

Charts 18485 (6265), 18484 (6266).-On the S side of the Strait of Juan de Fuca the coast trends E for 4 miles from Cape Flattery to **Koitlah Point**, the W point of Neah Bay. The shores are rugged, and the country is heavily timbered.

Neah Bay, about 5 miles E of Cape Flattery, is used extensively by small vessels as a harbor of refuge in foul weather. Its proximity to Cape Flattery and ease of access at any time make the anchorage very useful. It is protected from all but E weather.

Baadah Point, the E entrance point to Neah Bay, is rocky and grass-covered for some distance back from the shore. **Waadah Island**, 0.3 mile N of Baadah Point, is 0.5 mile long, high, and wooded. A rubblestone breakwater extends from the W side of the bay to about the middle of Waadah Island. A reef and foul ground extend 0.2 mile from the SW side of the island. A wharf, used by the Coast Guard, is on the S end of the island. A light and fog signal are at each end of the island. A reef that bares, marked by a lighted bell buoy, extends 500 yards NW from **Dtokoah Point**, SE of the entrance.

The buildings of the Coast Guard station, 0.4 mile SW of Baadah Point, are prominent from the entrance.

The buoyed entrance to the bay is between Waadah Island and Baadah Point. Depths of 14 to 16 feet can be carried into the bay. The careful navigator can carry 16 feet through the entrance by use of the chart and by favoring the S side of the entrance, passing the lights close aboard that mark the ends of the Makah Indian T-head pier about 375 yards W of Baadah Point. After passing the lights let the chart be the guide to the best water. Anchorage is in 4 to 6 fathoms, sandy bottom.

The W shore of Neah Bay is high and precipitous, and bordered by craggy rock outcroppings. The shore E of the village of Neah Bay is a low sand beach to Baadah Point. The unmarked wreck of a 32-foot fishing vessel in 37 feet of water and covered 28 feet, is near the middle of the bay in 48°22'25"N., 124°36'50"W.; mariners are advised to exercise caution when anchoring in the vicinity of the wreck.

The Indian village of **Neah Bay**, on the SW shore of the bay, is the site of considerable sport fishing and logging. Logs are trucked to a boom on the breakwater, 900 yards from the W end, where rafts are made up.

Neah Bay is a **customs port of entry**. The customs officer also performs immigration duties. (See appendix for address.)

The Makah Indian T-head pier with a 300-foot face and privately marked at each end by a light, and the ruins of a T-head pier no longer visible, are about 375 and 500 yards SW of Baadah Point. Caution is advised in the vicinity of the pier in ruins, as submerged piles may exist. The Coast Guard pier is 0.5 mile W of Baadah Point.

Two cooperative fish piers, 1 mile and 1.2 miles SW of Baadah Point, have facilities for icing and supplying fishing boats. Limited berthage, electricity, gasoline, diesel fuel, water, and ice are available. Both piers have reported depths of 12 feet off the ends. There are many small-craft floats extending along the S shore of the bay. Neah Bay has no public haulout or repair facilities.

Storm warning display locations are listed on NOS charts and shown on the Marine Weather Services Charts published by the National Weather Service.

A paved highway extends along the Strait of Juan de Fuca to Port Angeles; telephone service is available.

Charts 18465 (6382), 18421 (6380).-Strait of Juan de Fuca, E end.-Hein Bank, with a least depth of 2¼ fathoms, lies 8.5 miles SE of Discovery Island; it is about 2 miles long in a N direction, within the 10-fathom curve, and 0.8 mile wide. The shoalest part of the bank is covered with thick kelp in the summer. It is marked by a lighted bell buoy.

Smith Island, 5 miles W of Whidbey Island and 8 miles ESE of Hein Bank, is irregular in shape and about 0.5 mile long. The E end is low, but rises abruptly to an elevation of 55 feet at its W end, terminating in a white perpendicular cliff composed of sand and gravel. Kelp extends from 1.5 miles W of the island, with a width of about 1.5 miles over depths of 4 to 6 fathoms; a rock covered 3½ fathoms lies about 1.8 miles W of the light. A rock that bares at lowest tides is about 0.3 mile W of the light. Strong currents set in and around the shoal area, especially on the flood, and deep-draft vessels should keep well outside the 10-fathom curve to avoid being set into danger. **Smith Island Light**(48°19.1'N., 122° 50.6'W), 97 feet above the water, is shown from a skeleton tower with a white square daymark near the W extremity of the island: a radiobeacon is at the station.

A restricted area of a air-to-surface weapon range is W of Smith Island. (See 204.220, chapter 2, for limits and regulations.)

Minor Island, small, low, and rocky, lies 1 mile NE of Smith Island, and at lowest tide is connected with it by a gravel and boulder spit. A light and fog signal are on the island.

The N part of Whidbey Island forms the E side of the Strait of Juan de Fuca. This part of the island has a uniform sandy shore backed by low and rolling upland of farm and wooded areas.

The aerolight (48°20.9'N., 122°40.2'W.) at Ault Field is conspicuous.

TIDAL DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	POSITION		DIFFERENCES				RANGES		Mean Tide Level
				Time		Height				
		Lat. N	Long. W	High water	Low water	High water	Low water	Mean	Diurnal	
		° ′	° ′	h. m.	h. m.	feet	feet	feet	feet	feet
	WASHINGTON			on ABERDEEN						
867	Destruction Island	47 40	124 23	-1 01	-1 03	*0.87	*0.87	6.6	8.7	4.7
869	La Push, Quillayute River	47 55	124 39	-1 00	-0 47	*0.84	*0.84	6.5	8.5	4.6
871	Cape Alava (Flattery Rocks)	48 10	124 44	-0 53	-0 39	*0.81	*0.81	6.0	8.2	4.4
	Strait of Juan de Fuca[1]									
873	Cape Flattery, Tatoosh Island	48 23	124 44	-0 46	-0 46	*0.80	*0.80	5.9	8.0	4.3
875	Neah Bay	48 22	124 37	-0 37	-0 36	*0.78	*0.78	5.5	7.9	4.3
877	Clallam Bay	48 16	124 15	-0 11	-0 08	*0.76	*0.76	5.0	7.7	4.3
879	Twin Rivers	48 10	123 57	+0 09	+0 11	*0.71	*0.71	4.4	7.0	4.1
				on PORT TOWNSEND						
879	Crescent Bay	48 10	123 44	-2 24	-2 00	*0.81	*0.81	4.1	6.7	4.1
881	Port Angeles	48 07	123 26	-1 26	-1 21	*0.87	*0.87	4.2	7.2	4.4
883	Dungeness	48 10	123 07	-0 47	-0 39	*0.92	*0.92	4.4	7.6	4.7
885	Sequim Bay entrance	48 05	123 03	-0 32	-0 05	*0.95	*0.95	4.8	7.9	4.8
887	Gardiner, Discovery Bay	48 04	122 55	-0 40	-0 15	*0.95	*0.95	4.8	7.9	4.8
889	Smith Island	48 19	122 50	-0 06	-0 23	*0.84	*0.84	4.2	7.0	4.5
891	Point Partridge	48 14	122 46	-0 04	-0 13	*0.93	*0.93	4.5	7.7	4.7

CURRENT DIFFERENCES AND OTHER CONSTANTS

No	PLACE	POSITION		TIME DIFFERENCES		VELOCITY RATIOS		MAXIMUM CURRENTS			
								Flood		Ebb	
		Lat.	Long.	Slack water	Maximum current	Maximum flood	Maximum ebb	Direction (true)	Average velocity	Direction (true)	Average velocity
		° ′	° ′	h. m.	h. m.			deg.	knots	deg.	knots
	WASHINGTON—BRITISH COLUMBIA COAST *Time meridian, 120°W.*	N.	W.	on SAN FRANCISCO BAY ENTRANCE							
795	Quillayute River entrance	47 55	124 38	-0 20	-0 20	0.1	0.4	015	0.3	195	1.3
800	Cape Alava, 4.4 miles west of*	48 10	124 50	-----	-----	----	----	----	----	----	----
805	Swiftsure Bank*	48 32	125 00	-----	-----	----	----	----	----	----	----
810	Vancouver Island, west coast§	-----	------	-----	-----	----	----	----	----	----	----
	STRAIT OF JUAN DE FUCA			on STRAIT OF JUAN DE FUCA ENT.							
815	STRAIT OF JUAN DE FUCA ENTRANCE	48 27	124 35	Daily predictions				115	0.6	290	1.5
				on ADMIRALTY INLET							
915	Discovery Bay entrance	48 06	122 54	(*)	(*)	(*)	(*)	----	----	----	----
920	Smith Island, 2.0 miles east of	48 19	122 48	(*)	+0 35	0.2	0.2	----	0.4	220	0.5
925	Smith Island, 1.4 miles SSW. of	48 18	122 51	+0 10	+0 15	0.4	0.4	090	0.7	280	1.0
930	Smith Island, 3.7 miles ESE. of	48 18	122 45	(*)	+1 25	(*)	0.3	----	(*)	225	0.9
935	Point Partridge, 1.6 miles NW. of	48 15	122 48	-----	(†)	----	0.4	----	----	175	1.1
940	Point Partridge, 3.7 miles west of	48 14	122 52	(*)	+0 30	0.2	0.8	140	0.4	250	2.1

ABERDEEN, WASHINGTON, 1976

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 W	0036	0.1	16 TH	0021	1.4
	0652	7.4		0626	7.1
	1241	2.9		1220	3.8
	1848	9.7		1805	8.7
2 TH	0139	0.2	17 F	0118	1.5
	0804	7.3		0732	7.0
	1348	3.2		1329	4.0
	1955	9.5		1914	8.6
3 F	0246	0.3	18 SA	0221	1.4
	0919	7.5		0837	7.3
	1457	3.2		1439	3.8
	2102	9.5		2020	8.8
4 SA	0349	0.1	19 SU	0322	1.1
	1023	7.9		0935	7.8
	1604	2.8		1542	3.3
	2207	9.5		2122	9.0
5 SU	0445	-0.1	20 M	0418	0.7
	1118	8.5		1028	8.5
	1702	2.2		1641	2.4
	2303	9.6		2221	9.4
6 M	0533	-0.3	21 TU	0510	0.3
	1200	8.9		1113	9.3
	1753	1.6		1732	1.5
	2355	9.7		2316	9.8
7 TU	0619	-0.3	22 W	0558	0.1
	1238	9.3		1156	10.0
	1839	1.1		1822	0.5
8 W	0041	9.6	23 TH	0011	10.1
	0700	-0.2		0642	0.0
	1310	9.5		1238	10.6
	1922	0.8		1909	-0.4
9 TH	0119	9.5	24 F	0102	10.2
	0739	0.1		0726	0.2
	1342	9.7		1317	11.1
	2001	0.5		1956	-1.0
10 F	0158	9.3	25 SA	0151	10.1
	0817	0.5		0809	0.5
	1411	9.7		1400	11.3
	2040	0.5		2042	-1.3
11 SA	0235	8.9	26 SU	0241	9.8
	0852	1.0		0854	1.1
	1443	9.6		1444	11.3
	2119	0.5		2131	-1.3
12 SU	0312	8.5	27 M	0334	9.3
	0929	1.6		0939	1.7
	1512	9.5		1531	11.0
	2158	0.7		2220	-1.0
13 M	0352	8.1	28 TU	0432	8.8
	1006	2.2		1029	2.4
	1545	9.4		1623	10.6
	2240	0.9		2315	-0.5
14 TU	0435	7.7	29 W	0534	8.3
	1043	2.8		1125	3.0
	1622	9.2		1722	10.0
	2325	1.2			
15 W	0525	7.3	30 TH	0012	0.1
	1125	3.4		0642	8.0
	1706	9.0		1226	3.4
				1828	9.5

OCTOBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 F	0113	0.6	16 SA	0037	1.6
	0751	8.0		0700	7.9
	1334	3.6		1300	4.3
	1938	9.1		1831	8.7
2 SA	0216	0.9	17 SU	0137	1.7
	0855	8.3		0758	8.3
	1443	3.3		1409	3.9
	2048	9.0		1947	8.7
3 SU	0319	1.0	18 M	0239	1.7
	0954	8.7		0854	8.9
	1549	2.8		1515	3.2
	2153	9.0		2056	8.9
4 M	0415	1.0	19 TU	0337	1.6
	1042	9.2		0946	9.6
	1644	2.1		1615	2.1
	2251	9.2		2159	9.2
5 TU	0503	0.9	20 W	0433	1.4
	1123	9.6		1033	10.4
	1733	1.4		1708	0.9
	2340	9.3		2257	9.7
6 W	0549	1.0	21 TH	0523	1.3
	1158	9.9		1118	11.1
	1819	0.8		1759	-0.2
				2336	10.0
7 TH	0027	9.4	22 F	0612	1.3
	0631	1.1		1203	11.7
	1231	10.1		1848	-1.1
	1859	0.4			
8 F	0105	9.3	23 SA	0048	10.2
	0709	1.4		0659	1.5
	1302	10.2		1246	12.0
	1938	0.1		1936	-1.6
9 SA	0143	9.2	24 SU	0141	10.2
	0748	1.7		0746	1.7
	1333	10.2		1332	12.1
	2015	0.0		2023	-1.8
10 SU	0218	9.0	25 M	0232	10.0
	0825	2.2		0833	2.1
	1402	10.2		1418	11.9
	2053	0.1		2112	-1.7
11 M	0254	8.8	26 TU	0327	9.7
	0902	2.7		0921	2.6
	1431	10.0		1507	11.5
	2132	0.3		2200	-1.2
12 TU	0331	8.5	27 W	0422	9.3
	0937	3.2		1013	3.1
	1505	9.8		1558	10.8
	2211	0.6		2251	-0.5
13 W	0413	8.2	28 TH	0520	9.0
	1016	3.6		1109	3.5
	1537	9.6		1700	10.1
	2253	1.0		2346	0.3
14 TH	0501	7.9	29 F	0623	8.9
	1059	4.0		1209	3.8
	1619	9.3		1804	9.3
	2341	1.3			
15 F	0556	7.8	30 SA	0042	1.0
	1154	4.3		0723	8.9
	1718	8.9		1314	3.8
				1915	8.8
			31 SU	0141	1.5
				0822	9.2
				1421	3.4
				2027	8.6

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY.

PORT TOWNSEND, WASHINGTON, 1976

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 W	0313	-0.4	16 TH	0253	0.8
	1109	6.7		1115	6.4
	1504	5.3		1459	5.5
	2058	7.5		2003	6.4
2 TH	0420	-0.4	17 F	0352	0.7
	1226	7.0		1223	6.7
	1620	5.6		1613	5.7
	2205	7.2		2123	6.3
3 F	0529	-0.3	18 SA	0451	0.7
	1327	7.3		1308	7.0
	1759	5.6		1730	5.4
	2318	7.0		2245	6.2
4 SA	0634	-0.2	19 SU	0548	0.6
	1413	7.5		1347	7.3
	1942	5.1		1834	4.9
5 SU	0031	6.9	20 M	0005	6.4
	0730	0.0		0644	0.6
	1455	7.7		1412	7.5
	2037	4.5		1927	4.2
6 M	0136	6.8	21 TU	0111	6.7
	0819	0.3		0730	0.7
	1531	7.8		1441	7.7
	2113	3.9		2013	3.2
7 TU	0235	6.8	22 W	0213	7.1
	0857	0.7		0820	1.0
	1559	7.7		1507	7.8
	2148	3.3		2055	2.2
8 W	0328	6.8	23 TH	0313	7.5
	0936	1.2		0907	1.4
	1624	7.6		1536	7.9
	2213	2.7		2137	1.1
9 TH	0418	6.8	24 F	0410	7.8
	1008	1.8		0949	2.1
	1651	7.5		1606	8.0
	2245	2.2		2223	0.2
10 F	0505	6.7	25 SA	0509	7.9
	1040	2.4		1035	2.9
	1713	7.3		1638	8.1
	2317	1.8		2308	-0.6
11 SA	0556	6.6	26 SU	0608	8.0
	1115	3.0		1120	3.7
	1737	7.2		1713	8.0
	2352	1.4		2354	-1.0
12 SU	0645	6.5	27 M	0710	7.9
	1150	3.6		1209	4.4
	1800	7.0		1751	7.9
13 M	0031	1.1	28 TU	0046	-1.1
	0744	6.4		0819	7.7
	1229	4.2		1301	5.0
	1825	6.9		1833	7.6
14 TU	0112	0.9	29 W	0141	-0.9
	0845	6.3		0932	7.6
	1311	4.7		1400	5.5
	1854	6.7		1926	7.2
15 W	0202	0.9	30 TH	0239	-0.5
	1002	6.3		1046	7.6
	1400	5.2		1518	5.6
	1921	6.6		2034	6.7

OCTOBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 F	0343	0.1	16 SA	0258	0.8
	1149	7.7		1117	7.5
	1732	5.3		1614	5.5
	2157	6.3		2050	5.7
2 SA	0449	0.6	17 SU	0357	1.1
	1242	7.8		1159	7.7
	1908	4.6		1728	4.9
	2329	6.1		2233	5.7
3 SU	0557	1.1	18 M	0456	1.5
	1324	7.8		1231	7.8
	1953	3.9		1823	3.9
4 M	0049	6.2	19 TU	0003	6.0
	0654	1.6		0552	1.9
	1403	7.8		1305	8.0
	2029	3.1		1909	2.8
5 TU	0157	6.5	20 W	0119	6.5
	0746	2.1		0652	2.4
	1433	7.8		1333	8.1
	2057	2.4		1948	1.6
6 W	0254	6.7	21 TH	0223	7.2
	0828	2.6		0742	2.9
	1459	7.7		1406	8.2
	2121	1.8		2030	0.4
7 TH	0345	7.0	22 F	0326	7.8
	0907	3.1		0838	3.6
	1526	7.5		1438	8.4
	2143	1.3		2114	-0.7
8 F	0433	7.2	23 SA	0421	8.4
	0943	3.7		0927	4.2
	1548	7.4		1513	8.4
	2212	0.8		2200	-1.5
9 SA	0519	7.3	24 SU	0520	8.7
	1015	4.1		1017	4.8
	1611	7.2		1547	8.4
	2244	0.5		2243	-1.9
10 SU	0601	7.4	25 M	0616	8.8
	1054	4.6		1108	5.3
	1633	7.1		1627	8.2
	2315	0.2		2331	-2.0
11 M	0646	7.4	26 TU	0715	8.8
	1129	5.0		1200	5.7
	1656	6.9		1711	7.9
	2351	0.1			
12 TU	0739	7.3	27 W	0020	-1.6
	1210	5.4		0811	8.7
	1713	6.8		1258	5.9
				1753	7.4
13 W	0033	0.2	28 TH	0109	-1.0
	0831	7.3		0912	8.6
	1257	5.7		1411	5.9
	1721	6.6		1859	6.7
14 TH	0117	0.3	29 F	0202	-0.2
	0930	7.3		1011	8.5
	1352	5.8		1634	5.5
	1718	6.4		2016	6.1
15 F	0205	0.5	30 SA	0301	0.8
	1027	7.4		1101	8.4
	1459	5.8		1807	4.6
	1739	6.1		2155	5.6
			31 SU	0357	1.7
				1146	8.3
				1859	3.7
				2338	5.6

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY.

SAN FRANCISCO BAY ENTRANCE (GOLDEN GATE), CALIF., 1976

F-FLOOD, DIR. 065° TRUE E-EBB, DIR. 245° TRUE

SEPTEMBER

DAY	SLACK WATER TIME	MAXIMUM CURRENT TIME	MAXIMUM CURRENT VEL.
	H.M.	H.M.	KNOTS
1 W	0106	0405	3.0F
	0724	0932	2.0E
	1256	1550	2.3F
	1847	2202	4.1E
2 TH	0218	0526	3.0F
	0836	1045	1.8E
	1414	1707	2.2F
	1956	2311	4.0E
3 F	0324	0637	3.2F
	0940	1206	1.9E
	1526	1821	2.4F
	2104		
4 SA		0021	4.0E
	0423	0735	3.4F
	1035	1323	2.2E
	1627	1924	2.7F
	2206		
5 SU		0123	4.1E
	0514	0824	3.6F
	1121	1412	2.6E
	1720	2017	3.0F
	2301		
6 M		0216	4.2E
	0559	0905	3.7F
	1202	1452	3.0E
	1808	2106	3.2F
	2352		
7 TU		0257	4.2E
	0640	0942	3.7F
	1239	1523	3.3E
	1851	2146	3.4F
8 W	0038	0336	4.1E
	0717	1014	3.6F
	1313	1555	3.6E
	1931	2225	3.4F
9 TH	0123	0411	3.9E
	0752	1045	3.4F
	1346	1628	3.7E
	2010	2300	3.3F
10 F	0205	0447	3.6E
	0826	1114	3.2F
	1417	1703	3.8E
	2048	2339	3.2F
11 SA	0248	0522	3.3E
	0858	1147	2.9F
	1448	1742	3.9E
	2128		
12 SU		0017	3.0F
	0332	0603	2.9E
	0930	1222	2.6F
	1520	1823	3.8E
	2210		
13 M		0058	2.7F
	0420	0645	2.5E
	1003	1301	2.3F
	1554	1906	3.6E
	2259		
14 TU		0149	2.5F
	0512	0732	2.1E
	1041	1343	2.0F
	1634	1953	3.5E
	2355		
15 W		0244	2.2F
	0612	0823	1.8E
	1129	1436	1.7F
	1723	2047	3.3E
16 TH	0057	0346	2.1F
	0716	0920	1.6E
	1236	1533	1.6F
	1823	2144	3.2E
17 F	0201	0455	2.2F
	0820	1022	1.5E
	1353	1642	1.6F
	1929	2243	3.3E
18 SA	0259	0558	2.4F
	0916	1123	1.8E
	1502	1743	1.9F
	2035	2342	3.5E
19 SU	0351	0651	2.8F
	1005	1222	2.2E
	1559	1841	2.3F
	2136		
20 M		0040	3.8E
	0438	0736	3.2F
	1048	1316	2.8E
	1649	1938	2.8F
	2233		
21 TU		0132	4.1E
	0522	0821	3.5F
	1128	1402	3.4E
	1735	2027	3.3F
	2327		
22 W		0222	4.4E
	0603	0859	3.8F
	1205	1448	4.1E
	1820	2115	3.8F
23 TH	0019	0309	4.5E
	0644	0938	3.9F
	1242	1533	4.6E
	1906	2203	4.2F
24 F	0112	0354	4.4E
	0725	1018	4.0F
	1319	1618	5.1E
	1953	2251	4.4F
25 SA	0205	0443	4.1E
	0807	1100	3.8F
	1358	1703	5.3E
	2042	2342	4.4F
26 SU	0300	0531	3.7E
	0850	1144	3.6F
	1440	1750	5.3E
	2136		
27 M		0036	4.2F
	0358	0624	3.2E
	0939	1233	3.2F
	1526	1841	5.1E
	2234		
28 TU		0133	3.8F
	0459	0717	2.7E
	1033	1326	2.8F
	1619	1937	4.7E
	2337		
29 W		0236	3.5F
	0603	0816	2.3E
	1139	1429	2.4F
	1720	2034	4.3E
30 TH	0044	0350	3.2F
	0709	0922	2.0E
	1254	1536	2.2F
	1829	2139	3.9E

OCTOBER

DAY	SLACK WATER TIME	MAXIMUM CURRENT TIME	MAXIMUM CURRENT VEL.
	H.M.	H.M.	KNOTS
1 F	0151	0504	3.1F
	0813	1038	2.0E
	1409	1655	2.1F
	1941	2248	3.7E
2 SA	0255	0609	3.2F
	0910	1206	2.2E
	1518	1812	2.4F
	2050		
3 SU		0002	3.5E
	0352	0706	3.3F
	1000	1305	2.6E
	1616	1912	2.7F
	2153		
4 M		0106	3.5E
	0443	0753	3.4F
	1043	1348	3.0E
	1707	2007	3.0F
	2249		
5 TU		0155	3.5E
	0528	0832	3.4F
	1122	1423	3.3E
	1752	2052	3.2F
	2340		
6 W		0236	3.4E
	0608	0907	3.3F
	1158	1456	3.6E
	1833	2131	3.4F
7 TH	0027	0310	3.3E
	0646	0938	3.1F
	1231	1524	3.9E
	1911	2206	3.4F
8 F	0111	0345	3.1E
	0721	1007	3.0F
	1303	1559	4.1E
	1948	2244	3.4F
9 SA	0154	0421	2.9E
	0754	1038	2.8F
	1334	1634	4.1E
	2025	2320	3.3F
10 SU	0237	0500	2.7E
	0826	1109	2.6F
	1404	1711	4.2E
	2103	2357	3.2F
11 M	0320	0539	2.5E
	0858	1146	2.3F
	1436	1752	4.1E
	2143		
12 TU		0039	3.0F
	0406	0622	2.2E
	0932	1227	2.1F
	1511	1834	3.9E
	2227		
13 W		0123	2.7F
	0456	0709	2.0E
	1013	1314	1.8F
	1551	1921	3.7E
	2316		
14 TH		0216	2.6F
	0549	0758	1.8E
	1106	1403	1.6F
	1640	2012	3.5E
15 F	0011	0313	2.5F
	0645	0854	1.8E
	1215	1502	1.6F
	1741	2109	3.4E
16 SA	0108	0410	2.5F
	0740	0953	1.9E
	1329	1608	1.6F
	1851	2206	3.4E
17 SU	0205	0504	2.7F
	0831	1052	2.3E
	1436	1711	1.9F
	2002	2306	3.4E
18 M	0259	0559	3.0F
	0918	1146	2.8E
	1533	1815	2.4F
	2110		
19 TU		0005	3.6E
	0349	0648	3.2F
	1000	1241	3.4E
	1624	1913	2.9F
	2213		
20 W		0100	3.7E
	0437	0734	3.5F
	1041	1330	4.1E
	1713	2005	3.5F
	2312		
21 TH		0152	3.8E
	0523	0818	3.7F
	1120	1417	4.8E
	1800	2056	4.1F
22 F	0009	0244	3.8E
	0608	0903	3.7F
	1200	1506	5.3E
	1848	2147	4.4F
23 SA	0104	0335	3.7E
	0654	0947	3.7F
	1241	1551	5.6E
	1937	2236	4.6F
24 SU	0200	0423	3.5E
	0740	1030	3.6F
	1324	1638	5.7E
	2028	2331	4.6F
25 M	0255	0516	3.2E
	0829	1119	3.3F
	1411	1728	5.6E
	2121		
26 TU		0024	4.4F
	0351	0607	2.9E
	0923	1212	3.0F
	1501	1819	5.3E
	2217		
27 W		0121	4.1F
	0449	0701	2.5E
	1023	1308	2.6F
	1558	1914	4.8E
	2317		
28 TH		0222	3.7F
	0548	0802	2.3E
	1132	1411	2.3F
	1700	2015	4.3E
29 F	0018	0330	3.5F
	0646	0906	2.2E
	1245	1522	2.1F
	1810	2116	3.7E
30 SA	0120	0435	3.3F
	0742	1020	2.3E
	1357	1642	2.1F
	1921	2222	3.3E
31 SU	0219	0536	3.2F
	0833	1137	2.6E
	1502	1756	2.3F
	2030	2329	3.0E

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.

STRAIT OF JUAN DE FUCA ENTRANCE, 1976

F-FLOOD, DIR. 115° TRUE E-EBB, DIR. 290° TRUE

SEPTEMBER

DAY	SLACK WATER TIME	MAXIMUM CURRENT TIME	MAXIMUM CURRENT VEL.	DAY	SLACK WATER TIME	MAXIMUM CURRENT TIME	MAXIMUM CURRENT VEL.
	H.M.	H.M.	KNOTS		H.M.	H.M.	KNOTS
1		0043	1.9E	16		0024	1.4E
W	0508	0740	0.8F	TH	0509	0723	0.4F
	1023	1354	1.1E		0947	1348	0.9E
		*1922	*			*1906	*
2		0154	1.8E	17		0123	1.4E
TH	0616	0853	0.8F	F	0608	0827	0.5F
	1140	1518	1.1E		1056	1500	0.9E
		*2044	*			*2020	*
3		0303	1.8E	18		0231	1.4E
F	0722	1001	0.8F	SA	0704	0929	0.5F
	1250	1626	1.2E		1200	1602	1.1E
		*2158	*			*2129	*
4		0411	1.8E	19		0333	1.4E
SA	0622	1102	0.9F	SU	0754	1024	0.6F
	1348	1727	1.3E		1255	1651	1.2E
		*2303	*			*2232	*
5		0512	1.8E	20		0436	1.5E
SU	0915	1151	0.9F	M	0841	1111	0.7F
	1435	1812	1.5E		1341	1732	1.4E
	2225				2150	2325	0.3F
6		0001	0.3F	21	0102	0527	1.6E
M	0136	0607	1.8E	TU	0925	1154	0.8F
	1003	1236	0.9F		1422	1813	1.6E
	1515	1855	1.6E		2214		
	2300						
7		0050	0.4F	22		0013	0.5F
TU	0238	0655	1.8E	W	0214	0620	1.7E
	1047	1318	0.9F		1008	1235	0.9F
	1548	1934	1.6E		1500	1849	1.8E
	2334				2245		
8		0133	0.5F	23		0101	0.8F
W	0331	0736	1.7E	TH	0316	0705	1.8E
	1129	1355	0.8F		1052	1314	0.9F
	1617	2005	1.7E		1536	1930	2.0E
					2320		
9	0008	0213	0.6F	24		0145	1.0F
TH	0418	0815	1.6E	F	0414	0752	1.8E
	1208	1424	0.7F		1137	1356	0.9F
	1642	2038	1.7E		1611	2008	2.1E
10	0042	0249	0.6F	25	0000	0232	1.1F
F	0500	0852	1.5E	SA	0509	0843	1.8E
	1247	1457	0.6F		1225	1436	0.8F
	1705	2109	1.7E		1646	2049	2.2E
11	0117	0328	0.6F	26	0044	0321	1.2F
SA	0541	0930	1.4E	SU	0604	0932	1.7E
	1328	1527	0.5F		1317	1521	0.6F
	1725	2141	1.7E		1721	2134	2.2E
12	0155	0406	0.6F	27	0132	0411	1.2F
SU	0621	1009	1.3E	M	0700	1025	1.5E
	1413	1558	0.3F		1416	1609	0.5F
	1744	2215	1.6E		1756	2223	2.1E
13	0235	0445	0.5F	28	0226	0507	1.1F
M	0703	1048	1.1E	TU	0759	1126	1.4E
		*1635	*		1528	1701	0.3F
		2252	1.6E		1832	2316	2.0E
14	0321	0533	0.5F	29	0326	0609	1.0F
TU	0750	1139	1.0E	W	0901	1232	1.3E
		*1714	*			*1803	*
		2333	1.5E				
15	0413	0622	0.4F	30		0015	1.8E
W	0844	1241	0.9E	TH	0432	0715	0.9F
		*1803	*		1005	1348	1.2E
						*1916	*

OCTOBER

DAY	SLACK WATER TIME	MAXIMUM CURRENT TIME	MAXIMUM CURRENT VEL.	DAY	SLACK WATER TIME	MAXIMUM CURRENT TIME	MAXIMUM CURRENT VEL.
	H.M.	H.M.	KNOTS		H.M.	H.M.	KNOTS
1		0129	1.6E	16		0037	1.3E
F	0544	0823	0.8F	SA	0505	0738	0.5F
	1110	1500	1.2E		1010	1420	1.1E
		*2041	*			*1955	*
2		0245	1.5E	17		0145	1.3E
SA	0654	0932	0.8F	SU	0607	0837	0.5F
	1210	1605	1.4E		1103	1516	1.2E
		*2156	*			*2109	*
3		0354	1.5E	18		0257	1.3E
SU	0759	1029	0.7F	M	0707	0930	0.6F
	1302	1658	1.5E		1154	1605	1.4E
	2125	2301	0.3F			*2214	*
4	0035	0458	1.5E	19		0405	1.3E
M	0857	1121	0.7F	TU	0803	1024	0.6F
	1345	1746	1.6E		1240	1653	1.7E
	2158	2352	0.5F		2108	2306	0.5F
5	0148	0553	1.5E	20	0108	0506	1.4E
TU	0948	1204	0.7F	W	0855	1112	0.7F
	1421	1823	1.7E		1324	1734	1.9E
	2230				2137	2355	0.8F
6		0039	0.6F	21	0220	0602	1.5E
W	0247	0640	1.5E	TH	0945	1156	0.7F
	1033	1243	0.6F		1405	1815	2.1E
	1452	1858	1.8E		2212		
	2301						
7		0116	0.7F	22		0044	1.0F
TH	0336	0723	1.5E	F	0322	0651	1.6E
	1116	1316	0.5F		1034	1242	0.7F
	1519	1931	1.8E		1444	1856	2.2E
	2332				2250		
8		0156	0.8F	23		0133	1.2F
F	0420	0758	1.4E	SA	0419	0743	1.6E
	1157	1350	0.5F		1124	1324	0.6F
	1542	2000	1.8E		1523	1937	2.3E
					2332		
9	0003	0227	0.8F	24		0219	1.4F
SA	0500	0837	1.4E	SU	0513	0833	1.6E
	1239	1420	0.4F		1217	1413	0.6F
	1602	2032	1.8E		1602	2024	2.4E
10	0035	0304	0.8F	25	0017	0308	1.4F
SU	0538	0915	1.3E	M	0606	0925	1.6E
	1324	1454	0.3F		1314	1458	0.5F
	1619	2059	1.8E		1640	2109	2.3E
11	0108	0337	0.8F	26	0105	0356	1.4F
M	0617	0953	1.2E	TU	0659	1017	1.5E
		*1523	*		1420	1551	0.3F
		2130	1.7E		1718	2158	2.1E
12	0145	0417	0.8F	27	0157	0448	1.3F
TU	0657	1036	1.1E	W	0751	1117	1.4E
		*1600	*			*1647	*
		2203	1.6E			2252	1.9E
13	0225	0500	0.7F	28	0254	0543	1.1F
W	0739	1123	1.1E	TH	0845	1221	1.4E
		*1641	*			*1752	*
		2246	1.5E			2355	1.7E
14	0312	0543	0.6F	29	0358	0643	0.9F
TH	0825	1216	1.0E	F	0938	1325	1.4E
		*1735	*			*1908	*
		2335	1.4E				
15	0405	0638	0.6F	30		0103	1.5E
F	0916	1317	1.0E	SA	0507	0749	0.8F
		*1838	*		1030	1433	1.4E
						*2030	*
				31		0219	1.3E
				SU	0619	0851	0.7F
					1120	1533	1.5E
						*2141	*

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
*CURRENT WEAK AND VARIABLE.

ADMIRALTY INLET (OFF BUSH PT.), WASH., 1976

F-FLOOD, DIR. 180° TRUE E-EBB, DIR. 005° TRUE

SEPTEMBER

DAY	SLACK WATER TIME H.M.	MAXIMUM CURRENT TIME H.M.	MAXIMUM CURRENT VEL. KNOTS
1		0112	3.3E
W	0512	0809	2.0F
	1126	1426	1.7E
	1750	1955	0.8F
	2154		
2		0221	3.1E
TH	0620	0924	2.0F
	1242	1543	1.7E
	1917	2111	0.6F
	2301		
3		0330	3.0E
F	0726	1031	2.1F
	1349	1656	1.9E
	2032	2228	0.7F
4	0019	0441	3.0E
SA	0827	1132	2.3F
	1445	1755	2.1E
	2130	2336	0.9F
5	0134	0542	3.1E
SU	0921	1221	2.4F
	1530	1844	2.4E
	2217		
6		0033	1.2F
M	0241	0636	3.1E
	1009	1309	2.4F
	1609	1925	2.6E
	2258		
7		0118	1.4F
TU	0338	0725	3.0E
	1053	1346	2.3F
	1642	2005	2.8E
	2336		
8		0159	1.6F
W	0429	0806	2.9E
	1133	1420	2.2F
	1711	2036	2.9E
9	0011	0242	1.7F
TH	0515	0844	2.8E
	1210	1454	2.0F
	1738	2109	3.0E
10	0045	0317	1.7F
F	0558	0923	2.6E
	1247	1526	1.7F
	1802	2140	2.9E
11	0119	0357	1.7F
SA	0640	0959	2.3E
	1324	1557	1.5F
	1826	2210	2.9E
12	0154	0433	1.7F
SU	0722	1039	2.1E
	1405	1628	1.2F
	1849	2245	2.8E
13	0232	0514	1.6F
M	0807	1120	1.8E
	1450	1703	0.9F
	1913	2320	2.6E
14	0315	0559	1.5F
TU	0858	1209	1.6E
	1545	1744	0.6F
	1937		
15		0003	2.5E
W	0403	0652	1.4F
	0957	1306	1.4E
	1657	1833	0.4F
	2005		
16		0052	2.3E
TH	0458	0755	1.3F
	1103	1415	1.3E
		*1935	*
17		0153	2.2E
F	0558	0858	1.4F
	1211	1531	1.4E
		*2050	*
18		0257	2.3E
SA	0657	1001	1.5F
	1311	1632	1.6E
	2035	2201	0.3F
	2324		
19		0405	2.4E
SU	0752	1054	1.7F
	1400	1721	1.9E
	2110	2304	0.6F
20	0052	0507	2.6E
M	0843	1141	2.0F
	1442	1804	2.3E
	2142	2355	1.1F
21	0207	0557	2.8E
TU	0930	1224	2.1F
	1519	1843	2.7E
	2216		
22		0044	1.6F
W	0312	0648	3.0E
	1015	1305	2.2F
	1553	1921	3.1E
	2251		
23		0130	2.0F
TH	0411	0736	3.1E
	1100	1346	2.3F
	1627	1957	3.5E
	2329		
24		0216	2.4F
F	0507	0825	3.1E
	1145	1423	2.2F
	1701	2038	3.8E
25	0011	0302	2.7F
SA	0602	0911	3.0E
	1232	1506	2.0F
	1737	2121	3.9E
26	0055	0352	2.9F
SU	0657	1002	2.8E
	1322	1549	1.8F
	1814	2204	3.9E
27	0143	0443	2.8F
M	0754	1055	2.5E
	1417	1636	1.4F
	1854	2253	3.7E
28	0236	0538	2.7F
TU	0854	1156	2.2E
	1521	1731	1.1F
	1937	2346	3.4E
29	0334	0639	2.4F
W	0958	1300	2.0E
	1637	1833	0.8F
	2028		
30		0048	3.1E
TH	0438	0743	2.2F
	1106	1415	1.9E
	1804	1949	0.6F
	2131		

OCTOBER

DAY	SLACK WATER TIME H.M.	MAXIMUM CURRENT TIME H.M.	MAXIMUM CURRENT VEL. KNOTS
1		0200	2.8E
F	0548	0855	2.1F
	1211	1530	2.0E
	1925	2111	0.6F
	2254		
2		0315	2.6E
SA	0657	1002	2.0F
	1310	1633	2.2E
	2027	2224	0.8F
3	0024	0425	2.5E
SU	0801	1100	2.0F
	1400	1729	2.5E
	2115	2333	1.1F
4	0144	0528	2.5E
M	0858	1153	1.9F
	1442	1818	2.7E
	2156		
5		0024	1.4F
TU	0251	0623	2.5E
	0949	1236	1.9F
	1518	1853	2.9E
	2233		
6		0106	1.7F
W	0346	0712	2.5E
	1034	1311	1.8F
	1549	1928	3.1E
	2306		
7		0148	1.9F
TH	0434	0751	2.5E
	1115	1346	1.6F
	1616	2000	3.1E
	2338		
8		0222	2.0F
F	0517	0831	2.4E
	1154	1421	1.4F
	1641	2030	3.1E
9	0009	0257	2.1F
SA	0557	0906	2.3E
	1233	1450	1.2F
	1705	2100	3.1E
10	0039	0333	2.1F
SU	0636	0945	2.1E
	1313	1520	1.0F
	1728	2131	3.0E
11	0111	0408	2.1F
M	0715	1021	2.0E
	1356	1555	0.8F
	1750	2200	2.9E
12	0146	0443	2.0F
TU	0757	1103	1.8E
	1446	1630	0.6F
	1811	2235	2.7E
13	0224	0524	1.9F
W	0842	1151	1.7E
	1547	1712	0.3F
	1834	2316	2.5E
14	0308	0613	1.8F
TH	0931	1245	1.6E
		*1801	*
15		0007	2.3E
F	0359	0707	1.7F
	1025	1349	1.6E
		*1904	*
16		0103	2.1E
SA	0457	0806	1.6F
	1120	1450	1.7E
		*2025	*
17		0212	2.0E
SU	0559	0904	1.6F
	1211	1548	2.0E
	2003	2137	0.4F
	2311		
18		0327	2.0E
M	0702	1002	1.7F
	1258	1637	2.3E
	2034	2241	0.9F
19	0050	0437	2.2E
TU	0801	1054	1.7F
	1340	1719	2.8E
	2107	2336	1.4F
20	0208	0536	2.4E
W	0856	1139	1.8F
	1420	1801	3.2E
	2143		
21		0026	2.0F
TH	0315	0630	2.6E
	0949	1227	1.9F
	1458	1843	3.7E
	2221		
22		0114	2.6F
F	0415	0723	2.7E
	1039	1309	1.8F
	1536	1925	4.0E
	2301		
23		0202	3.0F
SA	0510	0812	2.8E
	1130	1356	1.8F
	1615	2009	4.2E
	2344		
24		0246	3.3F
SU	0604	0903	2.8E
	1222	1439	1.6F
	1655	2052	4.2E
25	0029	0335	3.4F
M	0657	0955	2.7E
	1316	1527	1.4F
	1736	2139	4.1E
26	0117	0424	3.3F
TU	0750	1049	2.5E
	1416	1616	1.1F
	1819	2229	3.8F
27	0208	0518	3.0F
W	0845	1147	2.3E
	1524	1718	0.8F
	1907	2324	3.4F
28	0304	0615	2.7F
TH	0940	1251	2.2E
	1642	1822	0.6F
	2003		
29		0022	2.9E
F	0405	0717	2.4F
	1036	1356	2.2E
	1803	1939	0.5F
	2115		
30		0136	2.4E
SA	0510	0818	2.1F
	1131	1503	2.3E
	1913	2102	0.6F
	2248		
31		0251	2.1E
SU	0619	0922	1.8F
	1221	1601	2.5E
	2008	2213	0.9F

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
*CURRENT WEAK AND VARIABLE.

APPENDIX F

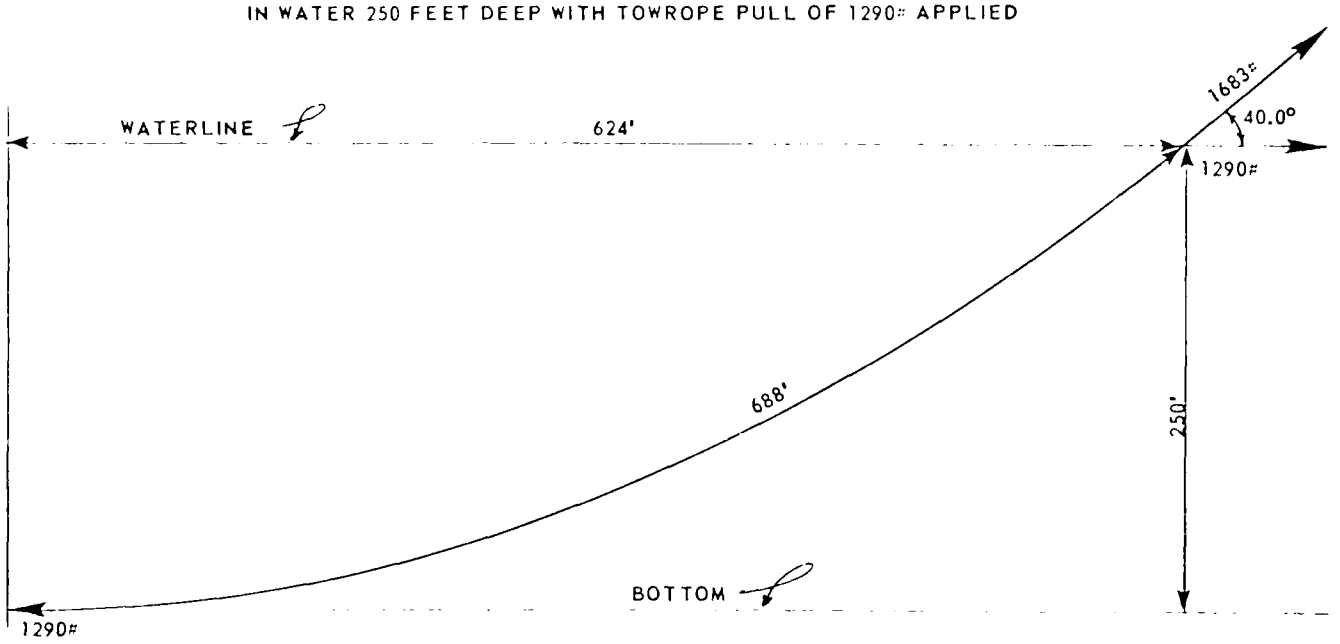
CATENARY DATA FOR
ITT CABLE AND COMMUNICATIONS CABLE

During the cable-laying activities in the 13th Coast Guard District, two different types of cable will be used and will be installed in water depths down to 300 feet. The allowable tension in the cable during the laying operations is established by the strength of the cable splices on one hand and the load limit of the cable machine on the other. The estimated maximum load at dead pull should not exceed 5,000 pounds tension in either case. At the suggested 1.5 knot towing speed the available towrope pull should be on the order of 1290 pounds.

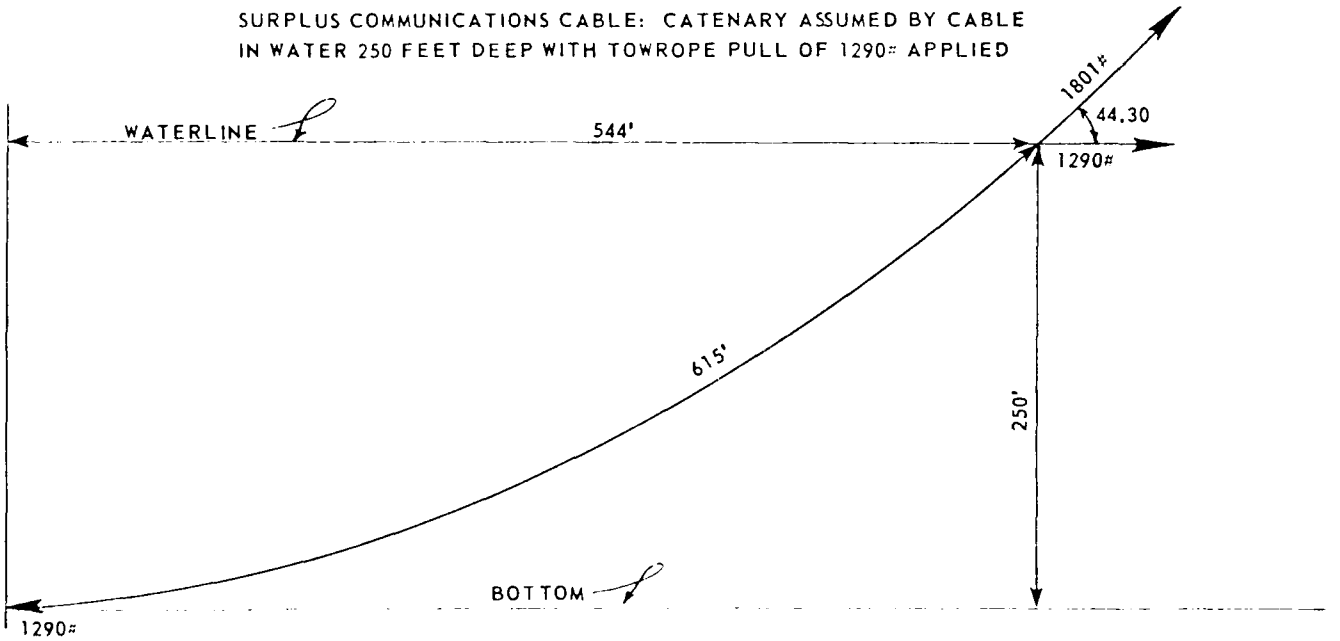
Since there will be neither a towrope pull nor a cable tension measuring device available for this operation, the only way to estimate the tension in the cable during these operations is to observe the angle made by the cable with the water surface at the point of entry. This has been designated as the *lead-off angle*; it is equivalent to the arc cosine of the horizontal force (or towrope pull) divided by the cable tension. The cable tension is equal to the towrope pull plus the weight of the cable suspended from the surface. The latter is a function of the weight of cable per unit length in water (1.571 #/ft for the ITT cable and 2.045 #/ft for the communications cable) and the water depth.

In Figure F-1 the catenary configuration, dimensions, and forces for equivalent depth and towrope pull conditions are illustrated for each of the cables. Figures F-2 and F-3 are working curves that give the cable tension and the towrope pull for the ITT cable as functions of the lead-off angle and water depth. Figures F-4 and F-5 provide similar working information for the surplus communications cable. After the towing speeds and control elements have been established for each operation; the target lead-off angles can be derived.

ITT POWER CABLE: CATENARY ASSUMED BY CABLE
IN WATER 250 FEET DEEP WITH TOWROPE PULL OF 1290# APPLIED



SURPLUS COMMUNICATIONS CABLE: CATENARY ASSUMED BY CABLE
IN WATER 250 FEET DEEP WITH TOWROPE PULL OF 1290# APPLIED

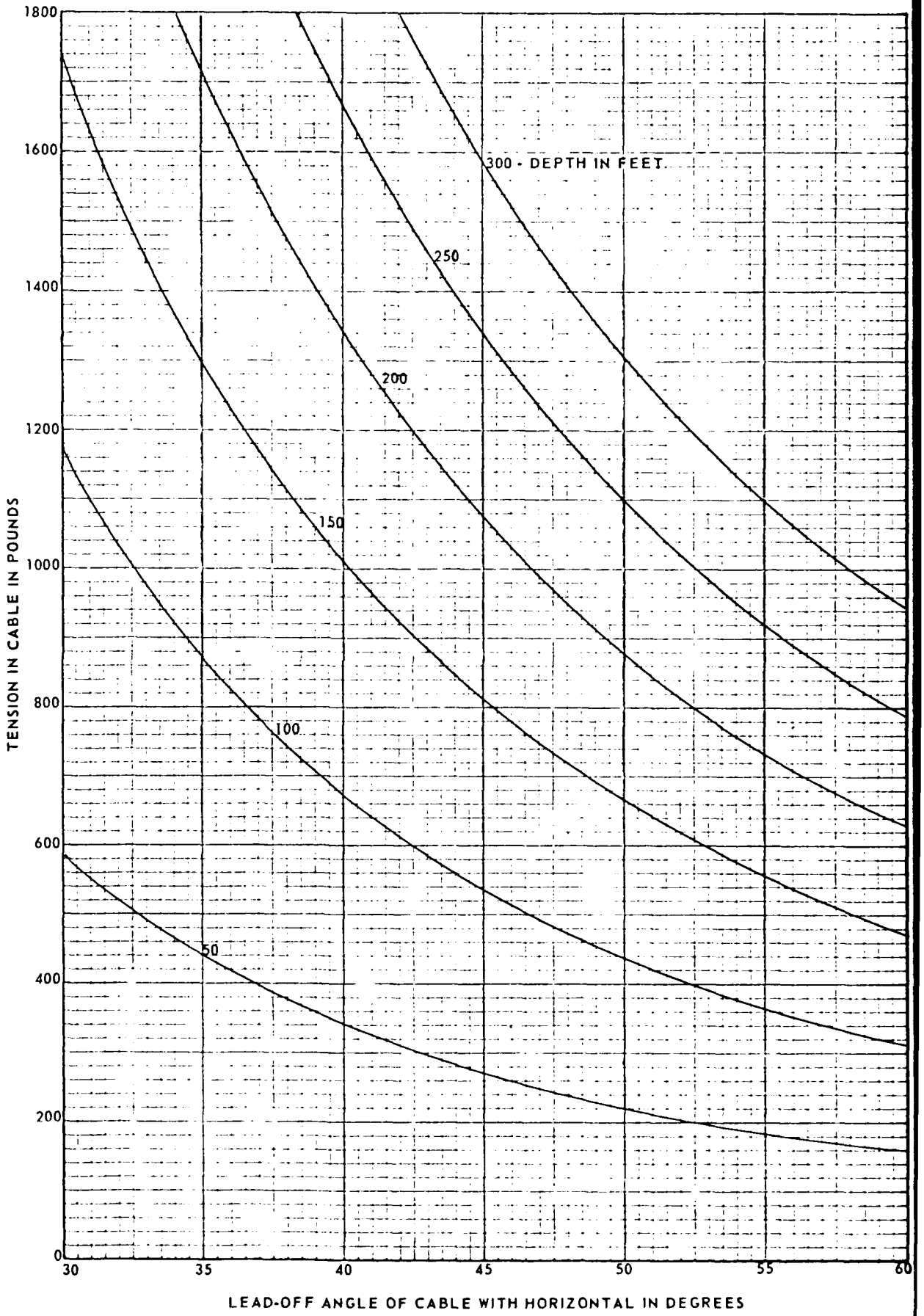


CABLE CATENARIES FOR ITT POWER CABLE AND
SURPLUS COMMUNICATIONS CABLE UNDER IDENTICAL
CONDITIONS OF WATER DEPTH AND TOWROPE PULL

FIGURE F-1

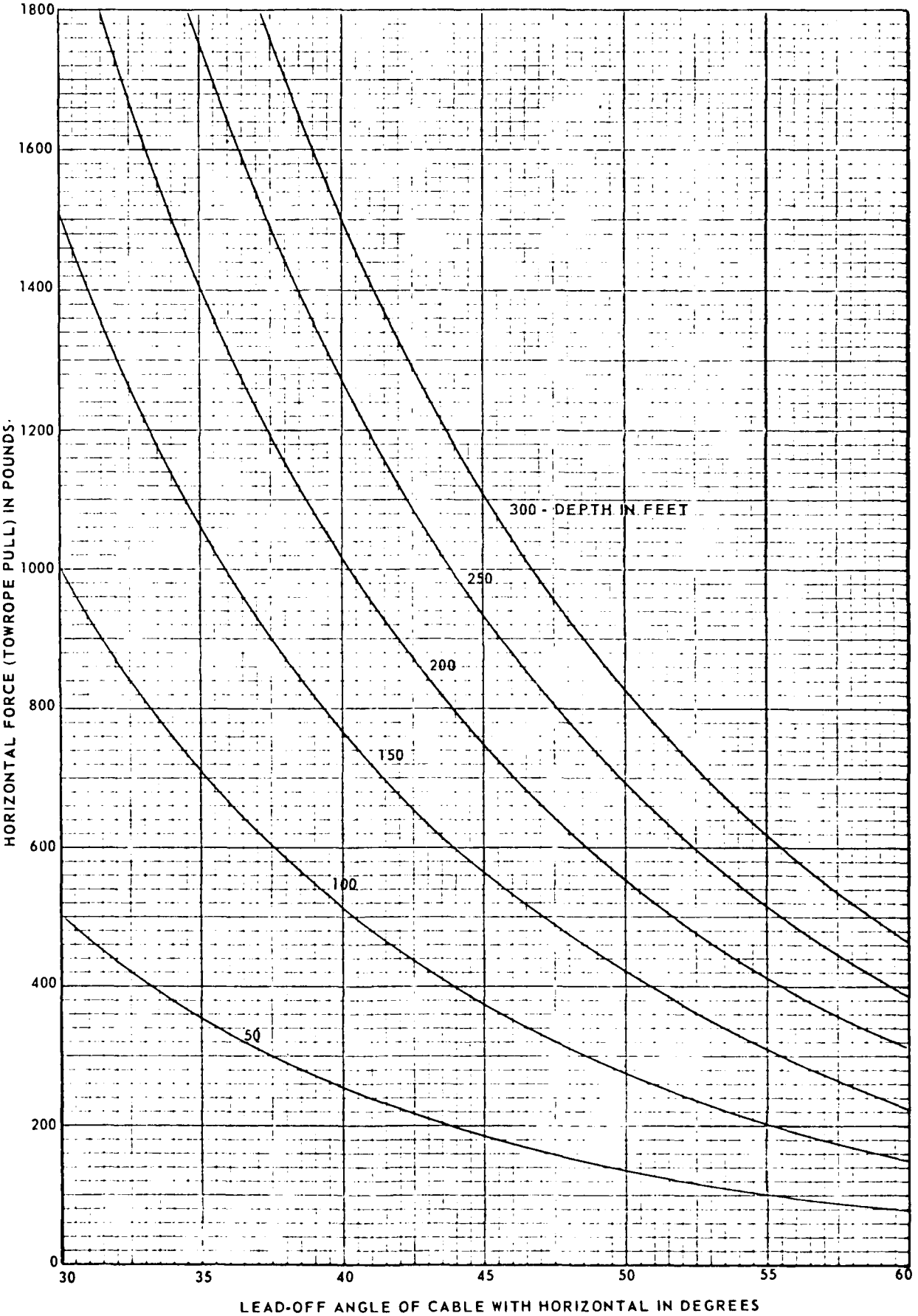
ITT POWER CABLE: CABLE TENSION VERSUS LEAD-OFF ANGLE

FIGURE F-2



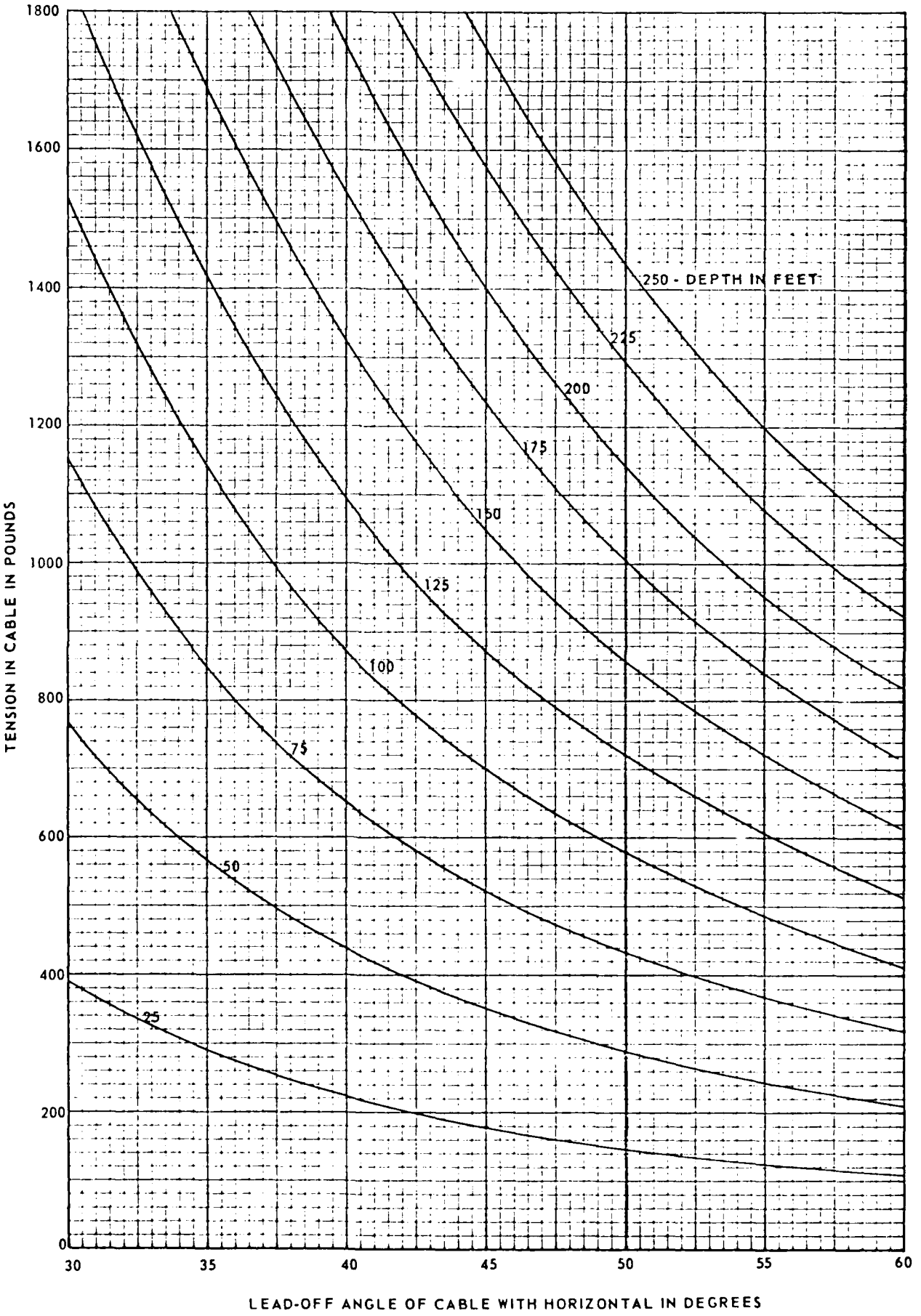
ITT POWER CABLE: HORIZONTAL FORCE TO MAINTAIN CABLE TENSION

FIGURE F-3



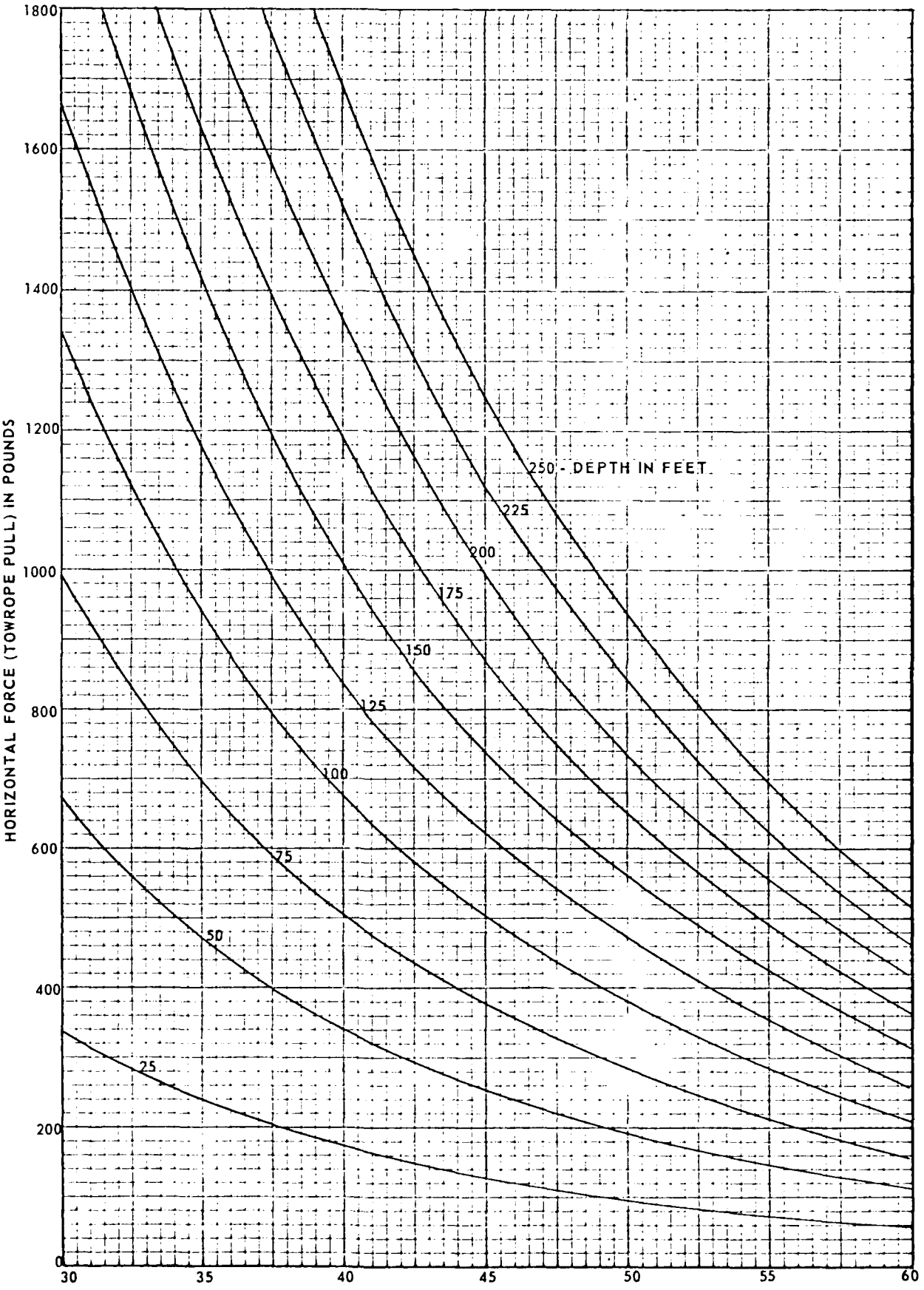
SURPLUS COMMUNICATIONS CABLE: CABLE TENSION VERSUS LEAD-OFF ANGLE

FIGURE F-4



SURPLUS COMMUNICATIONS CABLE: HORIZONTAL FORCE TO MAINTAIN TENSION

FIGURE F-5



APPENDIX G

MISCELLANEOUS EQUIPMENT AND REQUIREMENTS LIST
AND
PERMITS ISSUED TO THE COAST GUARD
FOR THE CABLE-LAYING OPERATIONS

The following list is not a total list of all detail equipment and requirements for the three principal organizations involved. Each organization was expected to supply the equipment necessary to accomplish the tasks as outlined in the Project Execution Plan. The list was intended as a supplemental guide for certain specific requirements.

CHESNAVFACENGCOM

- Mini-Ranger System: Console, 3 transponders, spares, electrical leads and cables, batteries, battery leads, and straps. (This system may be supplied by the 13th Coast Guard District from the NOAA field survey office in Seattle.)
- Navigation Kit and Tools: Navigation charts.
- Four (4) Coast Guard COMCO "walkie-talkie" radios.
- Camera
- Film

UCT-2

- *LARC V* and *ZODIAC* plus gear and equipment to operate
- Extra split pipe sections and hardware, rock bolts for entire project, 600' of fire hose for split pipe filler.
- Cable float bags (50 each), lift bags (2 each)
- Two-inch diamter snatch block
- Roll of 12' sheet of clear polyethylene
- Portable depth recorder system plus three rolls recording paper
- Three surveyor's transits plus three tripods
- Assorted line for *LARC* and *ZODIAC*, for tying cable float bags, and for other requirements
- Miscellaneous gear for field work and for diving.

13th COAST GUARD DISTRICT

- YC-1092 barge on loan from Naval Torpedo Station, Keyport, Washington.
- CLAMM, cable chutes (2 each), cable brake, cable stayed fairlead frame.
- Ladders (2 each) for boarding barge (ladders to extend one foot below barge bottom for diver use).
- Timber (2 x 6 and 2 x 4) for constructing cable bin, and 4' x 8' sheets of 1/2" plywood for cable layer separators, plus spare plywood sheets (6 each) for use as shore site markers.
- International orange spray paint cans (10 each)
- 250 pound concrete clump anchors with eyes (16 each) plus 60 pound anchors (2 each Mushroom, Danforth, and Grapnel).
- 1,200 feet of 1" Nylon mooring line.
- Main cable fairlead block plus miscellaneous snatch blocks (6 each).
- Barge running lights (navigation lights), deck floodlights, plus generator and/or battery power.
- Electrical cable testing equipment (fault locating device and Megger); cable ends on barge to be left exposed for testing.
- 130' Coast Guard Buoy Tender; 42' (or equivalent) *SAR* boat.
- Trucks or vehicles on shore for cable hauling.

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

NOTICE OF AUTHORIZATION

[illegible] 19

A PERMIT TO INSTALL SUBMARINE CABLE (PROVIDE POWER FOR SMITH ISLAND LIGHT) IN STRAIT OF JUAN DE FUCA

AT WHIDBEY ISLAND AND SMITH ISLAND, ISLAND COUNTY, WASHINGTON

HAS BEEN ISSUED TO COMMANDER, 13TH COAST GUARD DISTRICT (FLP2) ON [illegible] 19

ADDRESS OF PERMITTEE 915 - 2ND AVENUE
SEATTLE, WA 98174

PERMIT NUMBER 071-OYB-1-003271

for JOHN A. POTEAT
District Engineer
Colonel, Corps of Engineers

ENG Form 4336
Jul 70

THIS NOTICE MUST BE CONSPICUOUSLY DISPLAYED AT THE SITE OF WORK.

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE, WASHINGTON 98124

NPSOP-RF

15 SEP 1976

Commander, 13th Coast Guard District (flp2)
915 - 2nd Avenue
Seattle, Washington 98174

Reference: 071-OYB-1-003271
13th Coast Guard District

Gentlemen:

Pursuant to your application of 2 March 1976, inclosed is a Department of the Army permit to install a submarine cable in the Strait of Juan de Fuca at Whidbey Island and Smith Island, Island County, Washington.

Sections 9 and 10 of the River and Harbor Act of March 3, 1899 and Section 404 of the Federal Water Pollution Control Act Amendments of 1972 make it unlawful to build or to commence to build any structure across or in navigable waters of the United States and/or to excavate, or fill, or in any manner to alter or to modify the course of such navigable waters, except on plans that have had the prior approval of the Chief of Engineers and the Secretary of the Army.

You are cautioned that if any changes in the location or plans of the structure or work are found necessary, a revised plan should be submitted promptly to this office and be given my approval prior to starting construction.

You are requested to notify this office when the work authorized by the inclosed permit is begun, and immediately after it is completed.

Sincerely yours,

for Robert R Spearman

JOHN A. POTEAT
Colonel, Corps of Engineers
District Engineer

1 Incl
Permit w/Notice of Authorization

DOT-CG13-413-76

Application No. 071-0YB-1-003271

Name of Applicant 13th Coast Guard District

Effective Date 15 SEP 1976

Expiration Date (If applicable) _____

DEPARTMENT OF THE ARMY
PERMIT

Referring to written request dated 2 March 1976 for a permit to:

(X) Perform work in or affecting navigable waters of the United States, upon the recommendation of the Chief of Engineers, pursuant to Section 10 of the Rivers and Harbors Act of March 3, 1899 (33 U.S.C. 403);

(X) Discharge dredged or fill material into navigable waters upon the issuance of a permit from the Secretary of the Army acting through the Chief of Engineers pursuant to Section 404 of the Federal Water Pollution Control Act (86 Stat. 816, P.L. 92-500);

( ) Transport dredged material for the purpose of dumping it into ocean waters upon the issuance of a permit from the Secretary of the Army acting through the Chief of Engineers pursuant to Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (86 Stat. 1052; P.L. 92-532);

Commander, 13th Coast Guard District (flp2) ← (Here insert the full name and address of the permittee)
915 - 2nd Avenue
Seattle, Washington 98174

is hereby authorized by the Secretary of the Army:

to install submarine cable (provide power for Smith Island light) ← (Here describe the proposed structure or activity, and its intended use. In the case of an application for a fill permit, describe the structures, if any, proposed to be erected on the fill. In the case of an application for the discharge of dredged or fill material into navigable waters or the transportation for discharge in ocean waters of dredged material, describe the type and quantity of material to be discharged.)

in Strait of Juan de Fuca ← (Here to be named the ocean, river, harbor, or waterway concerned.)

at Whidbey Island and Smith Island, Island County, Washington ← (Here to be named the nearest well-known locality—preferably a town or city—and the distance in miles and tenths from some definite point in the same, stating whether above or below or giving direction by points of compass.)

In accordance with the plans and drawings attached hereto which are incorporated in and made a part of this permit (on drawings: give file number or other definite identification marks): 071-0YB-1-003271, 1 Sheet

subject to the following conditions:

I. General Conditions:

a. That all activities identified and authorized herein shall be consistent with the terms and conditions of this permit; and that any activities not specifically identified and authorized herein shall constitute a violation of the terms and conditions of this permit which may result in the modification, suspension or revocation of this permit, in whole or in part, as set forth more specifically in General Conditions j or k hereto, and in the institution of such legal proceedings as the United States Government may consider appropriate, whether or not this permit has been previously modified, suspended or revoked in whole or in part.

b. That all activities authorized herein shall, if they involve a discharge or deposit into navigable waters or ocean waters, be at all times consistent with applicable water quality standards, effluent limitations and standards of performance, prohibitions, and pretreatment standards established pursuant to Sections 301, 302, 306 and 307 of the Federal Water Pollution Control Act of 1972 (P.L. 92-500; 86 Stat. 816), or pursuant to applicable State and local law.

c. That when the activity authorized herein involves a discharge or deposit of dredged or fill material into navigable waters, the authorized activity shall, if applicable water quality standards are revised or modified during the term of this permit, be modified, if necessary, to conform with such revised or modified water quality standards within 6 months of the effective date of any revision or modification of water quality standards, or as directed by an implementation plan contained in such revised or modified standards, or within such longer period of time as the District Engineer, in consultation with the Regional Administrator of the Environmental Protection Agency, may determine to be reasonable under the circumstances.

d. That the permittee agrees to make every reasonable effort to prosecute the work authorized herein in a manner so as to minimize any adverse impact of the work on fish, wildlife and natural environmental values.

e. That the permittee agrees to prosecute the work authorized herein in a manner so as to minimize any degradation of water quality.

f. That the permittee shall permit the District Engineer or his authorized representative(s) or designee(s) to make periodic inspections at any time deemed necessary in order to assure that the activity being performed under authority of this permit is in accordance with the terms and conditions prescribed herein.

g. That the permittee shall maintain the structure or work authorized herein in good condition and in accordance with the plans and drawings attached hereto.

h. That this permit does not convey any property rights, either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to property or invasion of rights or any infringement of Federal, State, or local laws or regulations, nor does it obviate the requirement to obtain State or local assent required by law for the activity authorized herein.

i. That this permit does not authorize the interference with any existing or proposed Federal project and that the permittee shall not be entitled to compensation for damage or injury to the structures or work authorized herein which may be caused by or result from existing or future operations undertaken by the United States in the public interest.

j. That this permit may be summarily suspended, in whole or in part, upon a finding by the District Engineer that immediate suspension of the activity authorized herein would be in the general public interest. Such suspension shall be effective upon receipt by the permittee of a written notice thereof which shall indicate (1) the extent of the suspension, (2) the reasons for this action, and (3) any corrective or preventative measures to be taken by the permittee which are deemed necessary by the District Engineer to abate imminent hazards to the general public interest. The permittee shall take immediate action to comply with the provisions of this notice. Within ten days following receipt of this notice of suspension, the permittee may request a hearing in order to present information relevant to a decision as to whether his permit should be reinstated, modified or revoked. If a hearing is requested, it shall be conducted pursuant to procedures prescribed by the Chief of Engineers. After completion of the hearing, or within a reasonable time after issuance of the suspension notice to the permittee if no hearing is requested, the permit will either be reinstated, modified or revoked.

k. That this permit may be either modified, suspended or revoked in whole or in part if the Secretary of the Army or his authorized representative determines that there has been a violation of any of the terms or conditions of this permit or that such action would otherwise be in the public interest. Any such modification, suspension, or revocation shall become effective 30 days after receipt by the permittee of written notice of such action which shall specify the facts or conduct warranting same unless (1) within the 30-day period the permittee is able to satisfactorily demonstrate that (a) the alleged violation of the terms and the conditions of this permit did not, in fact, occur or (b) the alleged violation was accidental, and the permittee has been operating in compliance with the terms and conditions of the permit and is able to provide satisfactory assurances that future operations shall be in full compliance with the terms and conditions of this permit; or (2) within the aforesaid 30-day period, the permittee requests that a public hearing be held to present oral and written evidence concerning the proposed modification, suspension or revocation. The conduct of this hearing and the procedures for making a final decision either to modify, suspend or revoke this permit in whole or in part shall be pursuant to procedures prescribed by the Chief of Engineers.

l. That in issuing this permit, the Government has relied on the information and data which the permittee has provided in connection with his permit application. If, subsequent to the issuance of this permit, such information and data prove to be false, incomplete or inaccurate, this permit may be modified, suspended or revoked, in whole or in part, and/or the Government may, in addition, institute appropriate legal proceedings.

m. That any modification, suspension, or revocation of this permit shall not be the basis for any claim for damages against the United States.

n. That the permittee shall notify the District Engineer at what time the activity authorized herein will be commenced, as far in advance of the time of commencement as the District Engineer may specify, and of any suspension of work, if for a period of more than one week, resumption of work and its completion.

o. That if the activity authorized herein is not started on or before _____ day of _____, 19____, (one year from the date of issuance of this permit unless otherwise specified) and is not completed on or before _____ day of _____, 19____ (three years from the date of issuance of this permit unless otherwise specified) this permit, if not previously revoked or specifically extended, shall automatically expire.

p. That no attempt shall be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the activity authorized by this permit.

q. That if the display of lights and signals on any structure or work authorized herein is not otherwise provided for by law, such lights and signals as may be prescribed by the United States Coast Guard shall be installed and maintained by and at the expense of the permittee.

r. That this permit does not authorize or approve the construction of particular structures, the authorization or approval of which may require authorization by the Congress or other agencies of the Federal Government.

s. That if and when the permittee desires to abandon the activity authorized herein, unless such abandonment is part of a transfer procedure by which the permittee is transferring his interests herein to a third party pursuant to General Condition v hereof, he must restore the area to a condition satisfactory to the District Engineer.

t. That if the recording of this permit is possible under applicable State or local law, the permittee shall take such action as may be necessary to record this permit with the Register of Deeds or other appropriate official charged with the responsibility for maintaining records of title to and interests in real property.

u. That there shall be no unreasonable interference with navigation by the existence or use of the activity authorized herein.

v. That this permit may not be transferred to a third party without prior written notice to the District Engineer, either by the transferee's written agreement to comply with all terms and condition of this permit or by the transferee subscribing to this permit in the space provided below and thereby agreeing to comply with all terms and conditions of this permit. In addition, if the permittee transfers the interests authorized herein by conveyance of realty, the deed shall reference this permit and the terms and conditions specified herein and this permit shall be recorded along with the deed with the Register of Deeds or other appropriate official.

The following Special Conditions will be applicable when appropriate:

STRUCTURES FOR SMALL BOATS: That permittee hereby recognizes the possibility that the structure permitted herein may be subject to damage by wave wash from passing vessels. The issuance of this permit does not relieve the permittee from taking all proper steps to insure the integrity of the structure permitted herein and the safety of boats moored thereto from damage by wave wash and the permittee shall not hold the United States liable for any such damage.

DISCHARGE OF DREDGED MATERIAL INTO OCEAN WATERS: That the permittee shall place a copy of this permit in a conspicuous place in the vessel to be used for the transportation and/or dumping of the dredged material as authorized herein.

ERECTION OF STRUCTURE IN OR OVER NAVIGABLE WATERS: That the permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the authorized structure or work, shall, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the waterway to its former conditions. If the permittee fails to comply with the direction of the Secretary of the Army or his authorized representative, the Secretary or his designee may restore the waterway to its former condition, by contract or otherwise, and recover the cost thereof from the permittee.

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

NOTICE OF AUTHORIZATION

19

A PERMIT TO INSTALL SUBMARINE CABLE (PROVIDE POWER FOR SMITH ISLAND LIGHT) IN STRAIT OF JUAN DE FUCA

AT WHIDBEY ISLAND AND SMITH ISLAND, ISLAND COUNTY, WASHINGTON

HAS BEEN ISSUED TO COMMANDER, 13TH COAST GUARD DISTRICT (FLP2) ON 19

ADDRESS OF PERMITTEE 915 - 2ND AVENUE
SEATTLE, WA 98174

PERMIT NUMBER 071-OYB-1-003271

for JOHN A. POTEAT
District Engineer
Colonel, Corps of Engineers

ENG Form 4336
Jul 70

THIS NOTICE MUST BE CONSPICUOUSLY DISPLAYED AT THE SITE OF WORK.

This permit shall become effective on the date of the District Engineer's signature.

Permittee hereby accepts and agrees to comply with the terms and conditions of this permit.

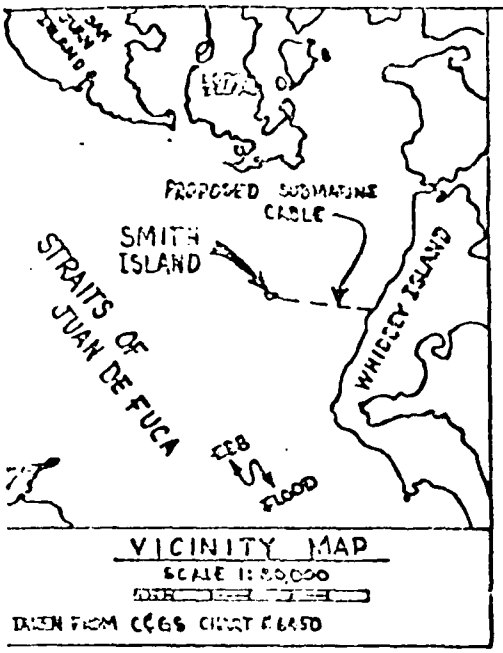
R. J. WILLIAMSON, LT USCG, Contracting Officer — 13 September 1976
13th Coast Guard District
PERMITTEE — DATE

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

for JOHN A. POTEAT, — 9/15/76
Colonel,
DISTRICT ENGINEER,
U.S. ARMY, CORPS OF ENGINEERS — DATE

Transferee hereby agrees to comply with the terms and conditions of this permit.

TRANSFEREE — DATE



NOTES

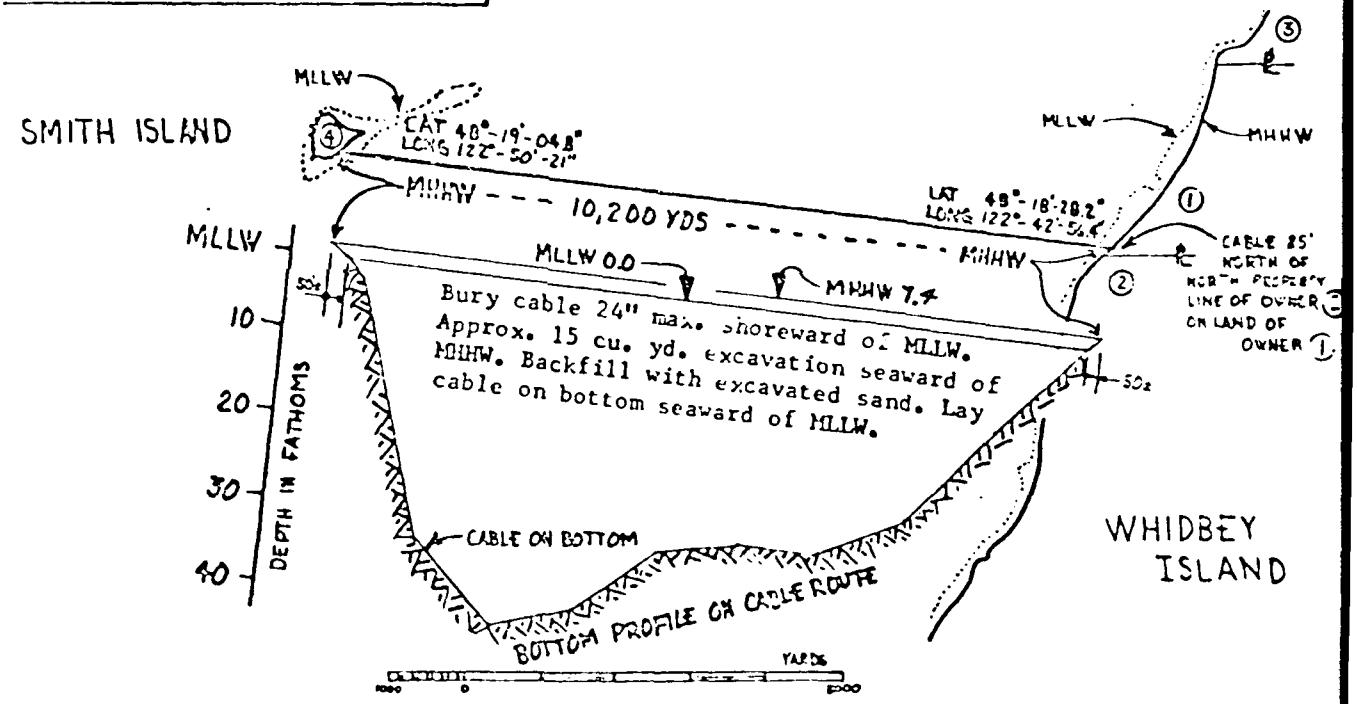
1. Purpose: To serve Smith Island Light
2. Federal Harbor Lines not established.
3. Datum: MLLW = 0.0
4. Names and addresses of adjacent property owners:

① Undeveloped and unnamed State Park
Washington State Department of Parks and Recreation
Olympia, WA 98507

② Mr. Francis E. Morgan
1948 Lower Oyster Bay Road
Bremerton, WA 98313

③ U. S. NAVY
U. S. Naval Air Station
Oak Harbor, WA 98277

④ Smith Island owned entirely by U. S. Coast Guard



PLAN VIEW TAKEN FROM CGGS # 6450

071-0YB-1-003271

PROPOSED SUBMARINE POWER CABLE

in STRAITS OF JUAN DE FUCA from WHIDBEY ISLAND to SMITH ISLAND in ISLAND COUNTY, WASHINGTON
Application by U. S. Coast Guard
DATE: 29 APRIL 76 SHEET 1 of 1

Reference: 071-CYB-1-00337/
US Coast Guard

I agree to conditions No. One - Five - Six - Nine
checked below which are pertinent to my proposed work.

(X) 1. All construction debris will be disposed on land in such a manner that it cannot enter navigable water.

( ) 2. All piling and lumber treated with creosote or other protective material will be completely dry before use in or near navigable water.

( ) 3. Care will be taken to prevent any petroleum products, chemicals or other deleterious materials from entering navigable water.

( ) 4. Only clean, durable riprap will be used.

(X) 5. All areas along the bank disturbed or newly created by the dredging activity will be seeded, riprapped or given some other equivalent type of protection against erosion.

(X) 6. Work in navigable water will be done to minimize turbidity which tends to degrade water quality and damage aquatic life.

( ) 7. Excavation or dredging will be conducted behind a berm of sufficient size to isolate the operation from navigable water.

( ) 8. Land disposal of dredging spoils will be accomplished behind adequately maintained protective berms which will prevent floating and sedimentary materials returning to navigable water.

(X) 9. If a bucket dredge of any type, including but not limited to grab or clamshell, dipper and dragline or backhaul bucket is used, all digging passes of the bucket will be completed without stockpiling spoils to obtain full buckets.

( ) 10. If a hydraulic dredge is used, the dredge will be operated with the intake at or below the surface of the material being removed.

( ) 11. Backwashing of the hydraulic dredge intake line will be held to an absolute minimum and, when backwashing is necessary, the intake will be raised no more than _____ feet above the bed material.

( ) 12. Waste water from hydraulic dredging operations will comply with appropriate water quality standards.

Byron J. Clark (WG013-ew) 29 April 1976

WAR DEPARTMENT

PERMIT

FOR FEDERAL AGENCIES

NPSKS 800.6(Neah Bay, Wash.)18/6

Corps of Engineers, US Army
Office of the District Engineer
Seattle District
Seattle, Washington

27 December, 1955

Commander
13th Coast Guard District
618 Second Avenue
To Seattle 4, Washington

The structures and work set forth in the plans hereto attached marked: "Route of Submarine Cable from Neah Bay, Washington to Tatoosh Island Application by the U. S. Coast Guard 17 October, 1955"

proposed by U. S. Coast Guard
(Bureau or establishment)

and presented in your letter dated 17 October 1955 comprising:

Laying submarine cable

from Neah Bay to Tatoosh Island

at Neah Bay, Washington

have been recommended by the Chief of Engineers and are authorized by the Secretary of War under the provisions of Section 10 of the act of Congress approved March 3, 1899 (30 Stat. 1151; 33 U. S. C. 403), subject to the following requirements:

16—16818

(a) That the execution of work shall be subject to such supervision and control by the District Engineer, Engineer Department at Large, in charge of the locality as he may find necessary in the interests of navigation.

(b) That any material dredged in the prosecution of the work herein authorized shall be removed evenly, and no large refuse piles, ridges across the bed of the waterway, or deep holes that may have a tendency to cause injury to navigable channels or to the banks of the waterway shall be left. If any pipe, wire, or cable hereby authorized is laid in a trench the formation of permanent ridges across the bed of the waterway shall be avoided, and the back filling shall be so done as not to increase the cost of future dredging for navigation. Any material to be deposited or dumped under this authorization, either in the waterway or on shore above high-water mark, shall be deposited or dumped at the locality shown on the drawing hereto attached, and, if so prescribed thereon, within or behind a good and substantial bulkhead or bulkheads, such as will prevent escape of the material into the waterway. If the material is to be deposited in the harbor of New York, or in its adjacent or tributary waters, or in Long Island Sound, a permit therefor must be previously obtained from the Supervisor of New York Harbor, Army Building, New York City.

(c) That no restriction other than provided by law shall be placed on the full and free use by the public of all navigable waters at and adjacent to the work or structure.

(d) That if future operations by the United States for the improvement of navigation require an alteration in the position of the structure or work herein authorized, or if in the opinion of the Secretary of War it shall cause an unreasonable obstruction to free navigation, the agency having the work in custody shall, upon due notice from the Secretary of War, remove or alter it so as to render navigation reasonably free, easy, and unobstructed.

(e) That if the display of lights and signals on any work hereby authorized is not otherwise provided for by law, such lights and signals as may be prescribed by the U. S. Coast Guard shall be installed and maintained.

(f) That the said District Engineer shall be promptly notified, in writing, of the commencement of work, suspension of work, if for a period of more than one week, resumption of work, and its completion.

(g) That the authorization herein conferred shall terminate if not availed of before the -----31st------ day of December, 1958

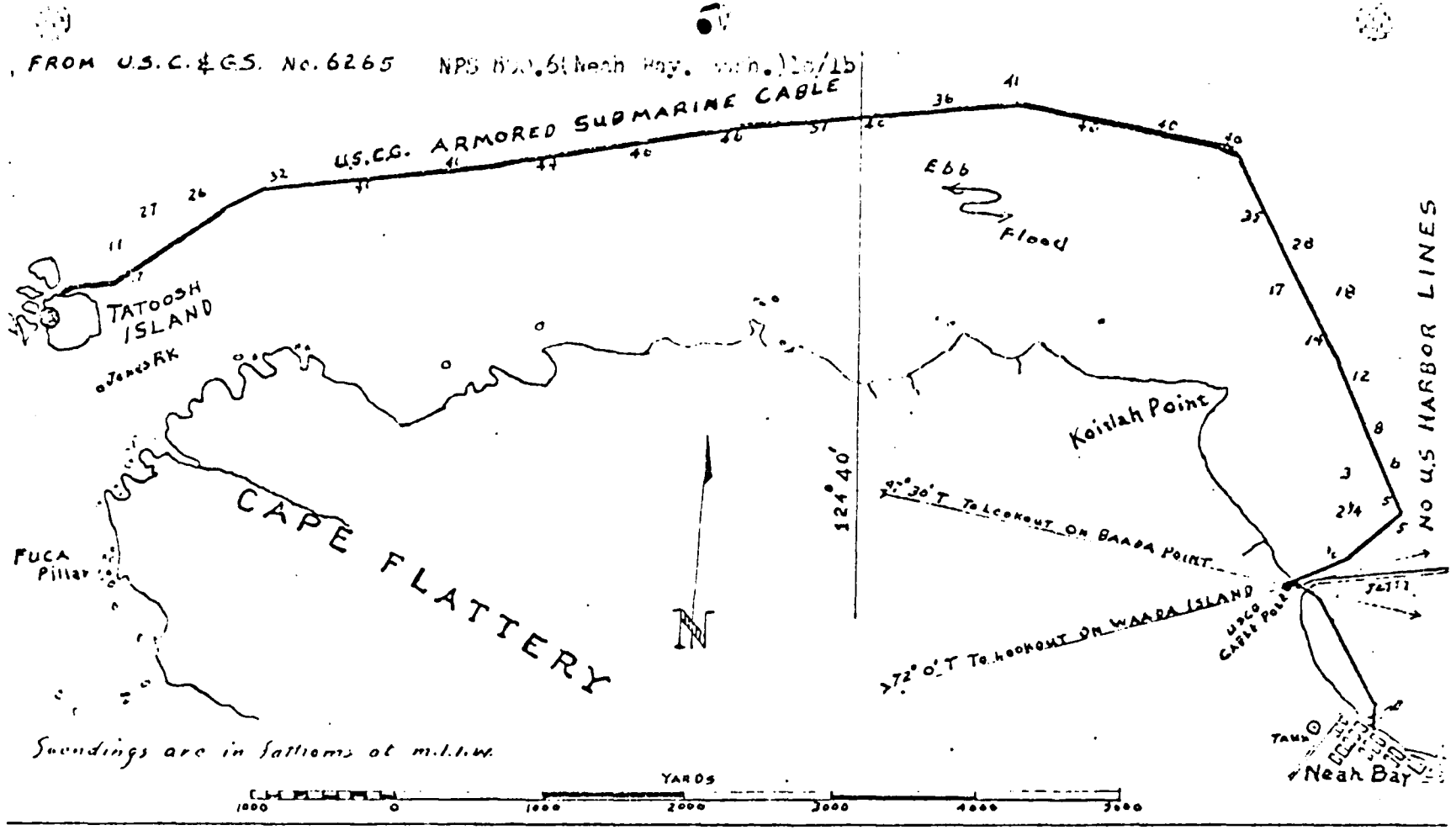
By authority of the Secretary of War:

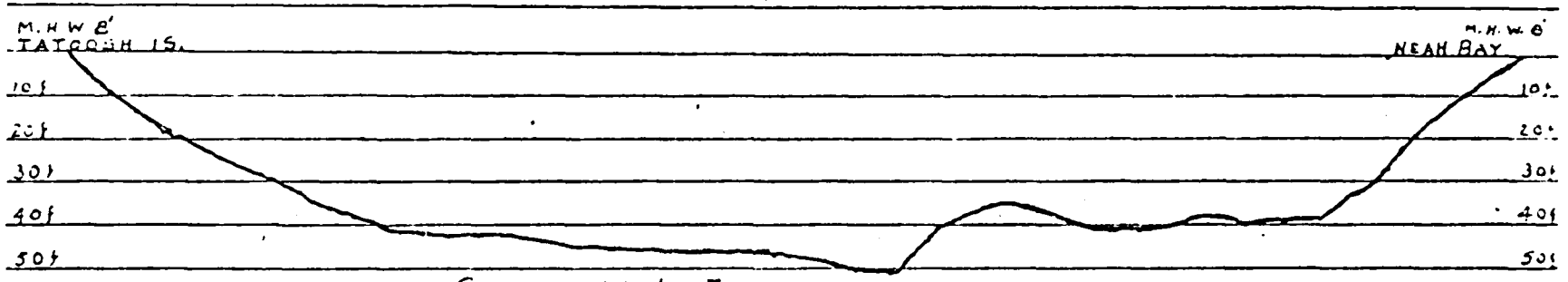
N. A. MATTHIAS
Colonel, Corps of Engineers
District Engineer

NOTE: The terms "War Department" and "Secretary of War" as used in this instrument will mean "Department of the Army" and "Secretary of the Army" respectively. Sec. 205 of the National Security Act of 1947 approved 26 July 1947, Public Law 253—80th Congress.)

WAR DEPARTMENT
O. C. of E.
Form 96d
(Revised Oct. 21, 1940)

U. S. GOVERNMENT PRINTING OFFICE 16—16410





SOUNDINGS IN FATHOMS AT M.L.L.W.
COURSE OF CABLE FOLLOWS FORTY FATHOM CURVE

No U.S. Harbor Lines established.

ROUTE OF SUBMARINE CABLE FROM NEAH BAY, WASHINGTON TO TATOOSH ISLAND.

APPENDIX H

NAVIGATION AND CABLE LOCATION DATA
FOR THE
SMITH ISLAND LIGHTHOUSE POWER CABLE

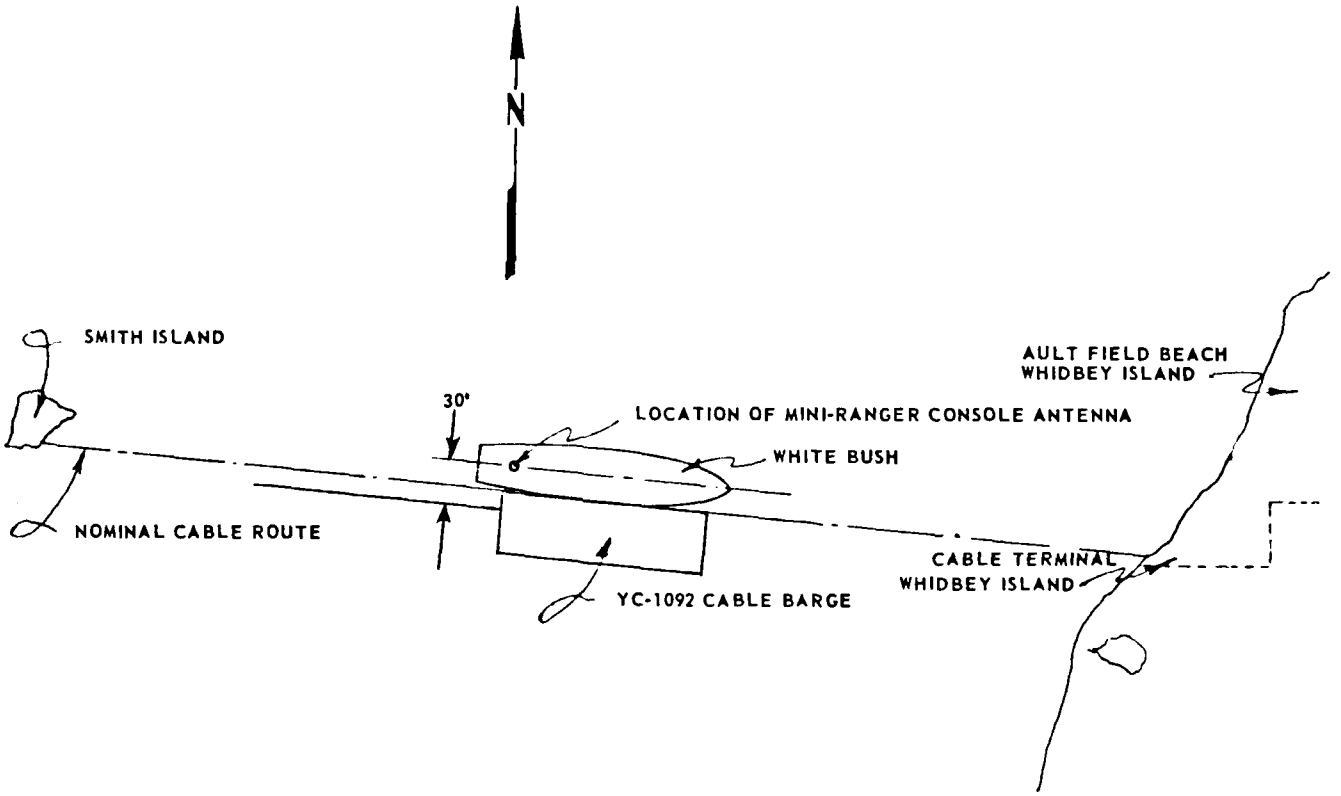
NAVIGATION ARRANGEMENTS

For the cable installation between Smith Island and Whidbey Island three (3) navigation stations were established on land, with the control (receiving) station aboard the U. S. Coast Guard Cutter *WHITE BUSH* (WLM-542).

The location of each of the 3 shore stations is detailed on the following forms, Navigation Format #1.

Site No. 1 - Smith Island
Site No. 2 - Whidbey Island - Cable Terminal
Site No. 3 - Whidbey Island - Ault Field Beach

The *WHITE BUSH* was towing the YC-1092 cable barge along the starboard side of the *WHITE BUSH*. The cable entry into the water from the barge was approximately in line with the Mini-Ranger console antenna on the *WHITE BUSH*. Therefore the cable and splice location as listed in the records herein will indicate approximately 30 feet north of the actual location of installation all along the cable route. This offset is shown in Figure H-1.



OFFSET OF CABLE PATH FROM MINI-RANGER POSITION LOCATIONS

FIGURE H-1

NAVIGATION FORMAT #1

LIGHTHOUSE Smith Island DATE 10/9/7
Installed FROM Smith Island TO Whidbey Island

FOR USE IN DETERMINING AND RECORDING:

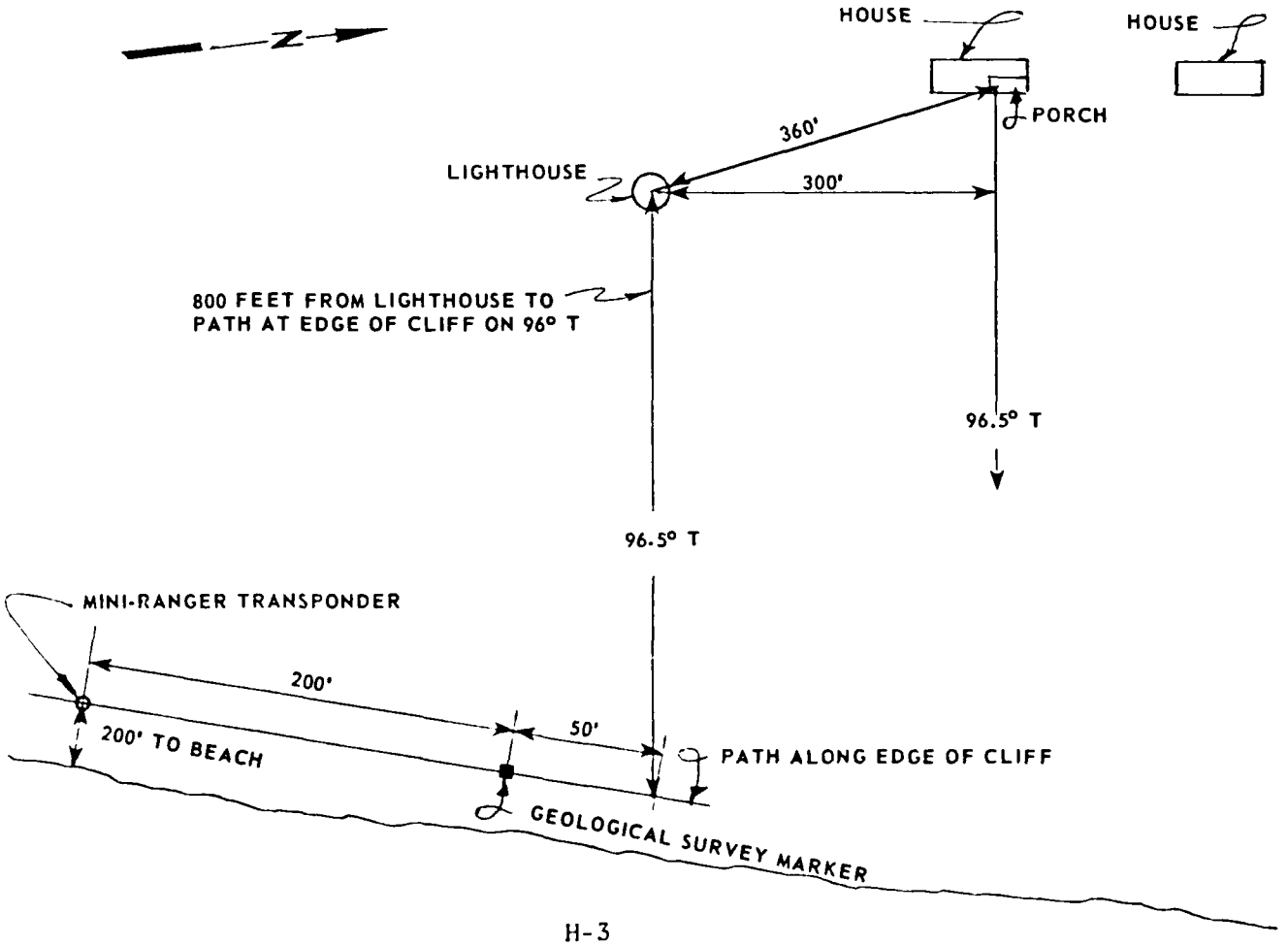
- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 1 SITE NAME OR DESCRIPTION Smith Island (near cable landing)

MINI-RANGER TRANSPONDER CHANNEL (CODE) One

TRANSIT ZERO ANGLE REFERENCE See sketch below

SITE LOCATION DETERMINATIONS: From lighthouse beach cable terminal site can be determined from sketch below. From beach site True bearing to Whidbey Island site is 097° T. Relative bearing from Smith Island beach site to Minor light is 031°.



NAVIGATION FORMAT #1

LIGHTHOUSE Smith Island DATE 10/9/76
Installed FROM Smith Island TO Whidbey Island

FOR USE IN DETERMINING AND RECORDING:

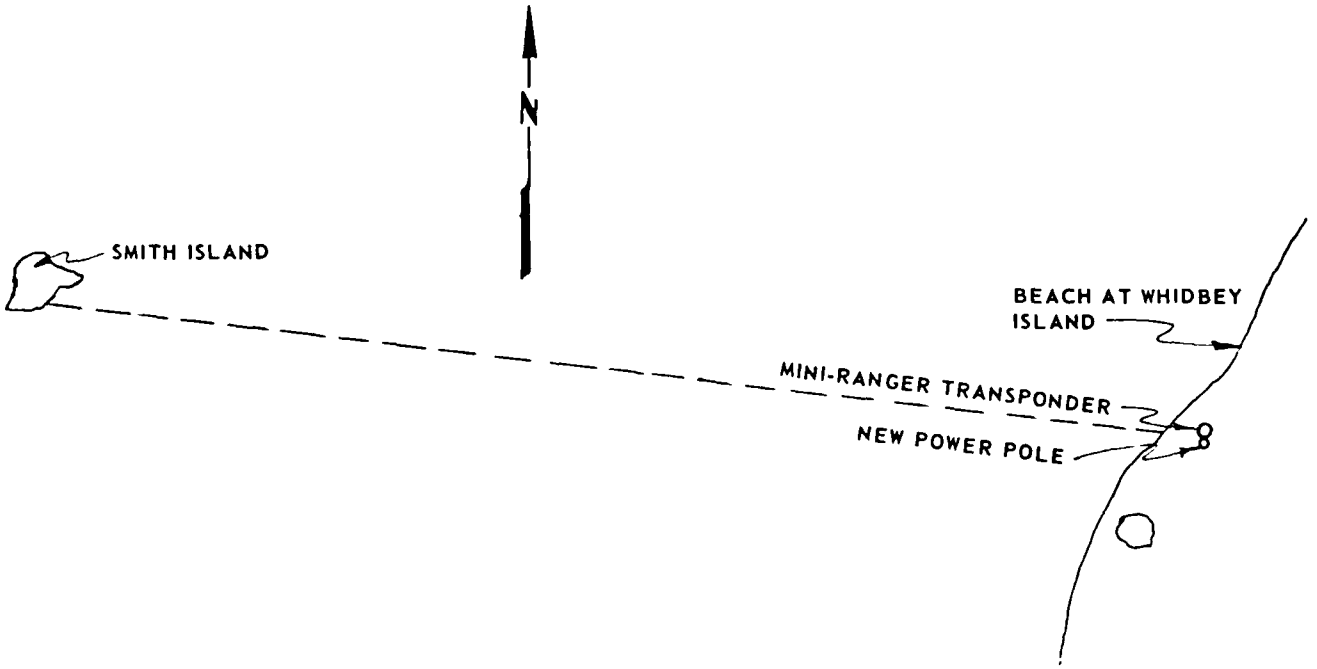
- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 2 SITE NAME OR DESCRIPTION Whidbey Island - at cable terminal

MINI-RANGER TRANSPONDER CHANNEL (CODE) Two

TRANSIT ZERO ANGLE REFERENCE

SITE LOCATION DETERMINATIONS: Mini-Ranger transponder placed next to new power pole at edge of top crest of beach, near parking area along road. (Site is designated in cable survey and site investigation sections of this completion report.)



NAVIGATION FORMAT #1

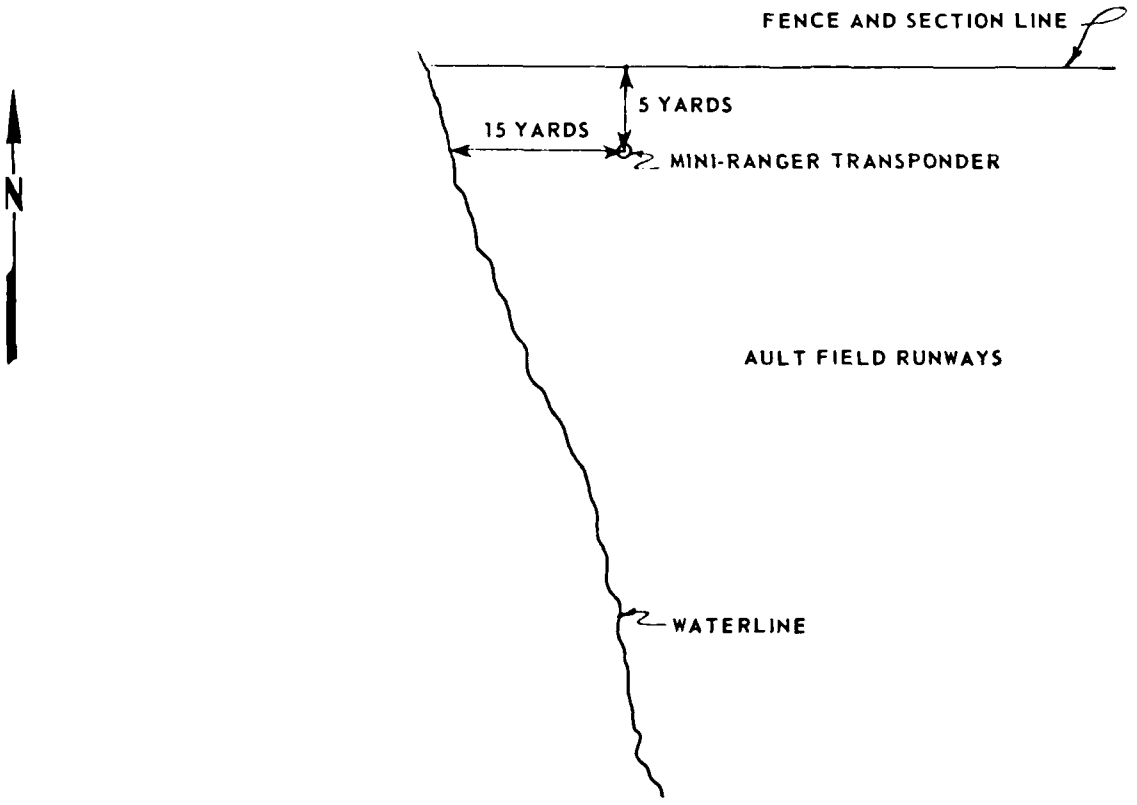
LIGHTHOUSE Smith Island DATE 10/9/7
FROM Smith Island TO Whidbey Island

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 3 SITE NAME OR DESCRIPTION Ault Field-Whidbey Island North of cable terminal
MINI-RANGER TRANSPONDER CHANNEL (CODE) Three
TRANSIT ZERO ANGLE REFERENCE None Used

SITE LOCATION DETERMINATIONS: Site is approximately 4.5 statue miles north along Whidbey Island coast. Fence at north edge of Ault Field property line runs along geological survey section mile line running east and west. Mini-Ranger transponder was placed 15 yards from the water line and 5-yards south of section line (fence line).

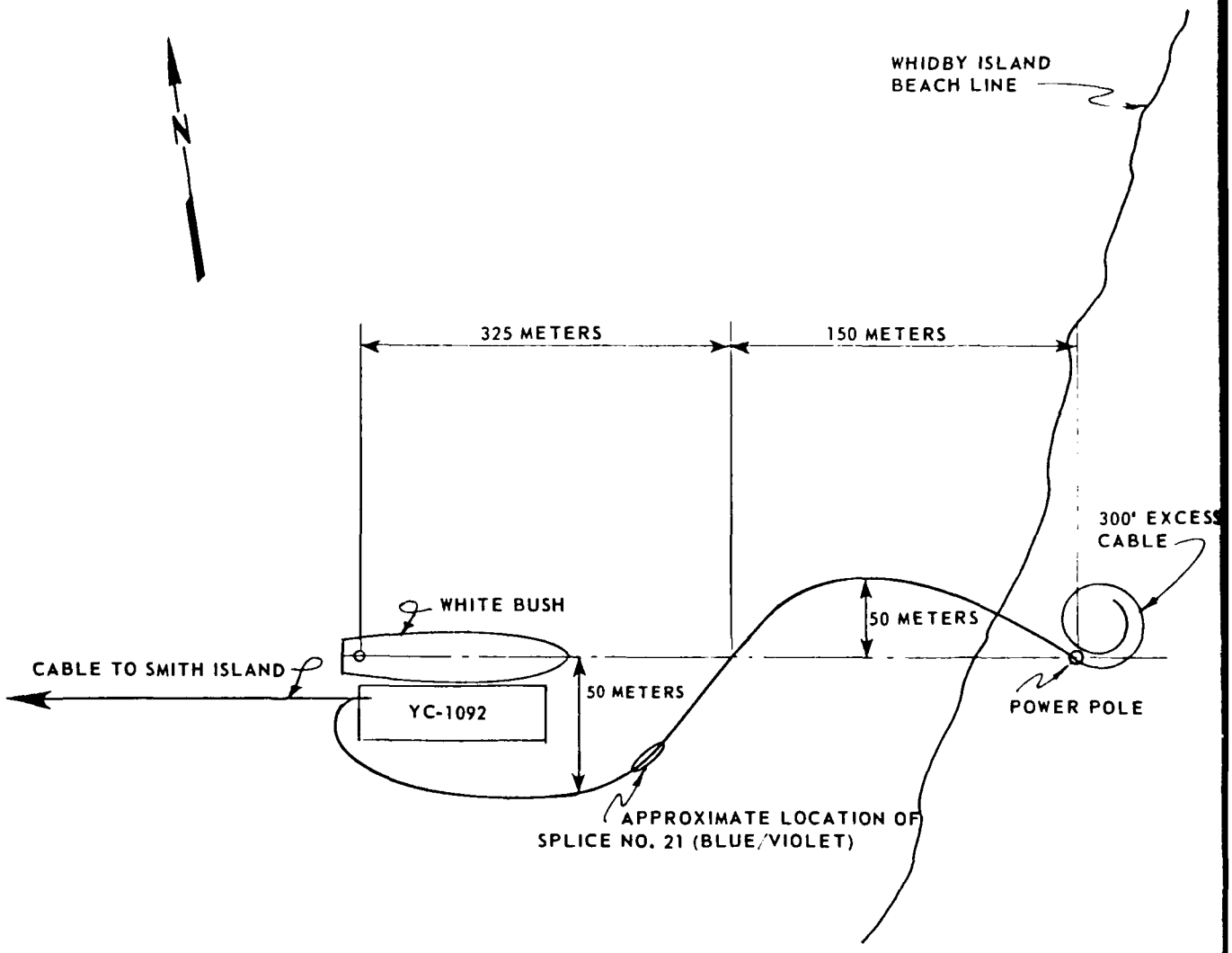


SHIP POSITION DATA - SMITH ISLAND TO WHIDBEY ISLAND - 9 OCTOBER 1976

TIME OF DAY	MINI-RANGER STATION READINGS RANGE IN METERS			REMARKS
	SITE 1 SMITH ISLAND	SITE 2 WHIDBEY ISLAND	SITE 3 AULT FIELD	
1155	545	8766	13745	DISTANCE TO S.I. MINI-RANGER 545 METERS = 1788 FT. MOORED AT SMITH ISLAND. CABLE BEING FLOATED ASHORE - 500' OF EXCESS CABLE HAULED ASHORE AT SMITH ISLAND. SPLICE NO. 34 (RED/ BROWN/RED) INSTALLED 1127 FT. FROM SMITH ISLAND BEACH LANDING.
1215	545	8765	13725	MOORED -FLOATING CABLE ASHORE
1249	654	8654	13668	UNDERWAY LAYING CABLE
1251	811	8493	13548	
1253	862	8455	13519	SPLICE NO. 33 (GREEN/RED/GREEN) INSTALLED
1255	876	8437	13522	
1257	948	8365	13472	
1258	1110	8200	13329	
1300	1255	8055	13190	SPLICE NO. 32 (ORANGE/RED/ORANGE) INSTALLED
1302	1365	7946	13080	
1304	1450	7848	12980	
1306	1570	7731	12840	
1308	1690	7611	12710	
1309	1774			SPLICE NO. 31 (BLUE/RED/BLUE) INSTALLED
1310	1785	7513	12640	
1312	2020	7260	12450	
1314	2190	7112	12330	SPLICE NO. 30 (SLATE/WHITE/SLATE) INSTALLED
1316	2420	6873	12160	
1318	2640	6664	11990	SPLICE NO. 29 (BROWN/WHITE/BROWN) INSTALLED
1320	2890	6406	11800	
1322	3110	6185	11630	
1323	3205			SPLICE NO. 28 (GREEN/WHITE/GREEN) INSTALLED
1324	3295	6006	11490	
1326	3530	5777	11310	
1328	3840	5448	11050	
1330	4040	5254	10900	
1331	4205			SPLICE NO. 27 (ORANGE/WHITE/ORANGE) INSTALLED
1332	4260	5031	10720	
1334	4400	4873	10600	
1337	5050	4250	10170	
1338	5208			SPLICE NO. 26 (BLUE/WHITE/BLUE) INSTALLED
1340	5375	3910	9940	
1342	5680	3610	9760	SPLICE NO. 25 (SLATE/VIOLET) INSTALLED
1344	5870	3420	9630	
1346	6260	3039	9410	
1348	6520	2783	9270	
1350	6840	2460	9080	SPLICE NO. 24 (BROWN/VIOLET) INSTALLED
1352	7060	2230	8930	
1354	7390	1905	8740	
1355	7503			SPLICE NO. 23 (GREEN/VIOLET) INSTALLED
1356	7610	1699	8635	
1358	7780	1537	8570	
1400	7950	1362	8510	
1402	8170	1160	8460	
1404	8350	1000	8395	
1405	8476			SPLICE NO. 22 (ORANGE/VIOLET) INSTALLED
1406	8540	820	8315	
1408	8770	600	8196	
1410	8835	548	8182	
1414	8740	656	8246	
1415	8650	683	8157	MANEUVERING TO FIND MOORING BUOYS
1416	8680	636	8094	
1417	8721	591	8045	
1418	8785	523	7992	
1419	8820	499	7990	
1420	8854	459	7953	
1421	8840	476	7964	AT MOORING BUOY - WHIDBEY ISLAND
1436	8831	483	7975	AT MOORING BUOY - WHIDBEY ISLAND

CABLE TERMINATION ON WHIDBEY ISLAND

Between 1630 and 1730 the cable was brought ashore on Whidbey Island. Due to the current force, fog, and restrictions on *LARC* operations, not all of the surface catenary could be pulled out of the cable before the float balloons were cut off and the cable dropped to the bottom. The cable configuration and location of Splice #21 are shown in Figure H-2.



SKETCH OF CABLE CONFIGURATION AS INSTALLED ON THE BOTTOM FROM WHIDBEY ISLAND OUT TO THE MOORED WHITE BUSH AND YC-1092

FIGURE H-2

APPENDIX I

NAVIGATION AND CABLE LOCATION DATA
FOR THE
CAPE FLATTERY LIGHTHOUSE POWER CABLE

NAVIGATION ARRANGEMENTS

Navigation sites for the Cape Flattery Lighthouse cable installations are described on the following five Navigation Format #1 sheets. A summary of these navigation sites and the navigation procedures follows. The cable was laid in three sections:

- o First Section from Tatoosh Island towards Neah Bay (buoyed with *SAR* boat).
- o Second Section spliced into end of First Section (Splice #1) while holding position at sea,then Second Section cable laid towards Neah Bay and buoyed off in shallow water when approaching breakwater to Waadah Island.
- o Third Section laid from beach power terminal location at Neah Bay out to end of Second Section and cable splice #2 made.

Navigation for First and Second Sections consisted of placing Mini-Ranger transponders at:

1. Waadah Island Light (north on Waadah Island)
2. Bahokus Peak (northermost AF Radar Dome)
3. Tatoosh Island (inside Cape Flattery Lighthouse)

In addition, a transit was placed in the cove at the cable landing point on Tatoosh Island to guide the *WHITE BUSH* out on the initial leg of the cable route.

The Mini-Ranger console receiving unit and antenna were located near the bridge aboard the *WHITE BUSH*. However, the Waadah Island Mini-Ranger transponder was inoperative throughout the project despite continuous servicing and replacement of batteries. Therefore, navigation depended upon use of the Tatoosh and Bahokus Mini-Ranger transponders. As back-up, the *WHITE BUSH* crew maintained a continuous plot of position based on visual and radar sights.

For the Third Cable Section the Mini-Ranger transponders were relocated to sites:

4. Cable landing beach location, Neah Bay
5. Building on end of Coast Guard Pier, Neah Bay

An additional site, on the breakwater to Waadah Island, was plotted to be in a direct line with one leg of the cable route. Use of this site was not necessary since Mini-Ranger readings were plotted quickly and proved sufficiently accurate to satisfy navigational requirements.

The precise location of the cable, and the location of the two splices, is presented on the enclosed chart reproduction of the cable lay, Figure I-1. The points, triangulated from Mini-Ranger ranges are given in the two tables following the plot. By Mini-Ranger range, the location of the first splice is 3904 meters from Cape Flattery Lighthouse, 3138 meters from the northernmost of three USAF radar domes on Bahokus Peak and, using the computer traced chart location, is 4800 meters from the beach landing at Neah Bay. The second splice location is 7797 meters from Cape Flattery Lighthouse, 4044 meters from Bahokus, 1750 meters from the beach landing Neah Bay, and 3222 meters from the end of the Coast Guard pier at Neah Bay.

NAVIGATION FORMAT #1

LIGHTHOUSE Cape Flattery DATE 10/14/7
FROM Tatoosh Isl. TO Second Splice

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 1 SITE NAME OR DESCRIPTION Waadah Island Light (northernmost light)
MINI-RANGER TRANSPONDER CHANNEL (CODE) One
TRANSIT ZERO ANGLE REFERENCE None

SITE LOCATION DETERMINATIONS: North (west) end of Waadah Island placed Mini-Ranger transponder on top of light platform, next to light - light is charted - no other Site Location Determination Required.

NAVIGATION FORMAT #1

LIGHTHOUSE Cape Flattery DATE 10/14/7
FROM Tatoosh Isl. TO Second Splice

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 2 SITE NAME OR DESCRIPTION Bahokus Peak
MINI-RANGER TRANSPONDER CHANNEL (CODE) Two
TRANSIT ZERO ANGLE REFERENCE None Required

SITE LOCATION DETERMINATIONS: Three radar domes are located on Makah Air Force Station facility on Bahokus Peak (charted on NOS & GS charts and maps). The Mini-Ranger transponder was placed on the north part of a catwalk near the top of one of the radar domes (northernmost of the three radar domes).

NAVIGATION FORMAT #1

LIGHTHOUSE Cape Flattery DATE 10/14/
FROM Tatoosh Isl. TO Second Splice

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 3 SITE NAME OR DESCRIPTION Cape Flattery

MINI-RANGER TRANSPONDER CHANNEL (CODE) Three

* TRANSIT ZERO ANGLE REFERENCE See note below.

SITE LOCATION DETERMINATIONS: Set-up Mini-Ranger transponder on top level of Cape Flattery Lighthouse, next to light. Light is charted - no other Site Location Determination Required.

*A transit station was located in the center of the center of the cable landing cove on Tatoosh Island next to (immediately south of) the large rock in the center of the cove. The bearing of the first leg of the cable installation is 063°T from this location. The *WHITE BUSH* provided accurate position determination and zero angle determination prior to start of cable lay.

NAVIGATION FORMAT #1

LIGHTHOUSE Cape Flattery DATE 10/15/7
FROM Neah Bay TO Second Splice

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

SITE NO. 5 SITE NAME OR DESCRIPTION Coast Guard Pier - Neah Bay
MINI-RANGER TRANSPONDER CHANNEL (CODE) Three
TRANSIT ZERO ANGLE REFERENCE

SITE LOCATION DETERMINATIONS: Western point of building (shack) on Coast Guard Pier - Neah Bay
Coordinates: 48° 22' 16.5" North Latitude
124° 36' 03.0" West Longitude

NAVIGATION FORMAT #1

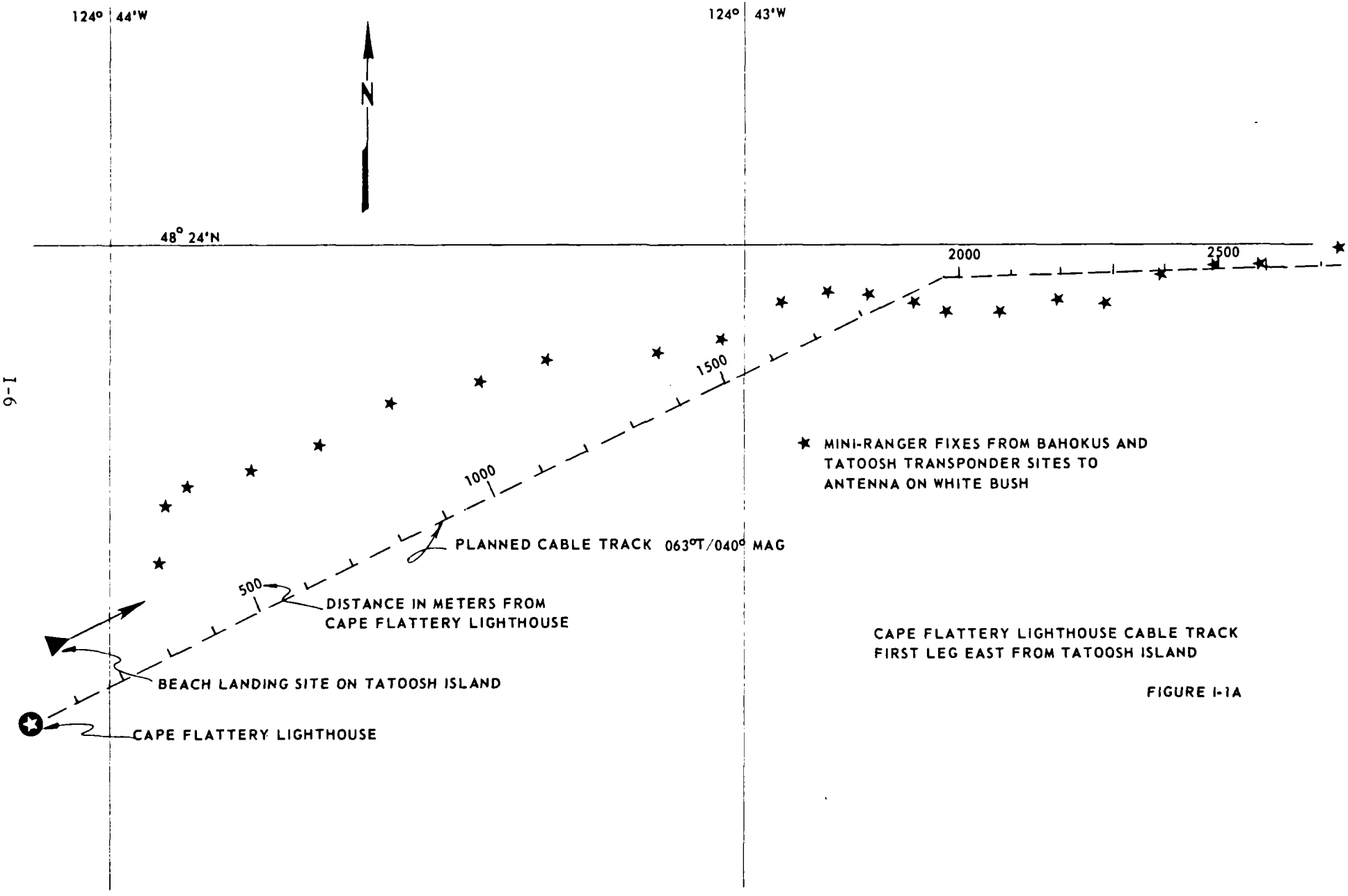
LIGHTHOUSE Cape Flattery DATE 10/15/7
FROM Neah Bay TO Second Splice

FOR USE IN DETERMINING AND RECORDING:

- THE PRECISE LOCATION AT EACH SITE OF THE MINI-RANGER TRANSPONDERS AND THE SURVEYOR'S TRANSITS, AND
- THE ZERO ANGLE REFERENCE USED WITH EACH OF THE SURVEYOR'S TRANSITS
- THE LOCATION AND ANGLE REFERENCE DATA WILL, IN MOST CASES, BE "RELATIVE" TO A KNOWN (CHARTED) LOCATION. IN CERTAIN INSTANCES THE LOCATION OR ANGLE REFERENCE WILL COINCIDE WITH ACTUAL CHARTED LANDMARKS OR TRUE OR MAGNETIC BEARING ANGLES. IF CHARTED REFERENCE LANDMARKS ARE NOT AVAILABLE, A DETAILED DESCRIPTION OF THE LANDMARK, AND METHODS USED IN LOCATING THE SITE RELATIVE TO THE LANDMARK, SHALL BE RECORDED.

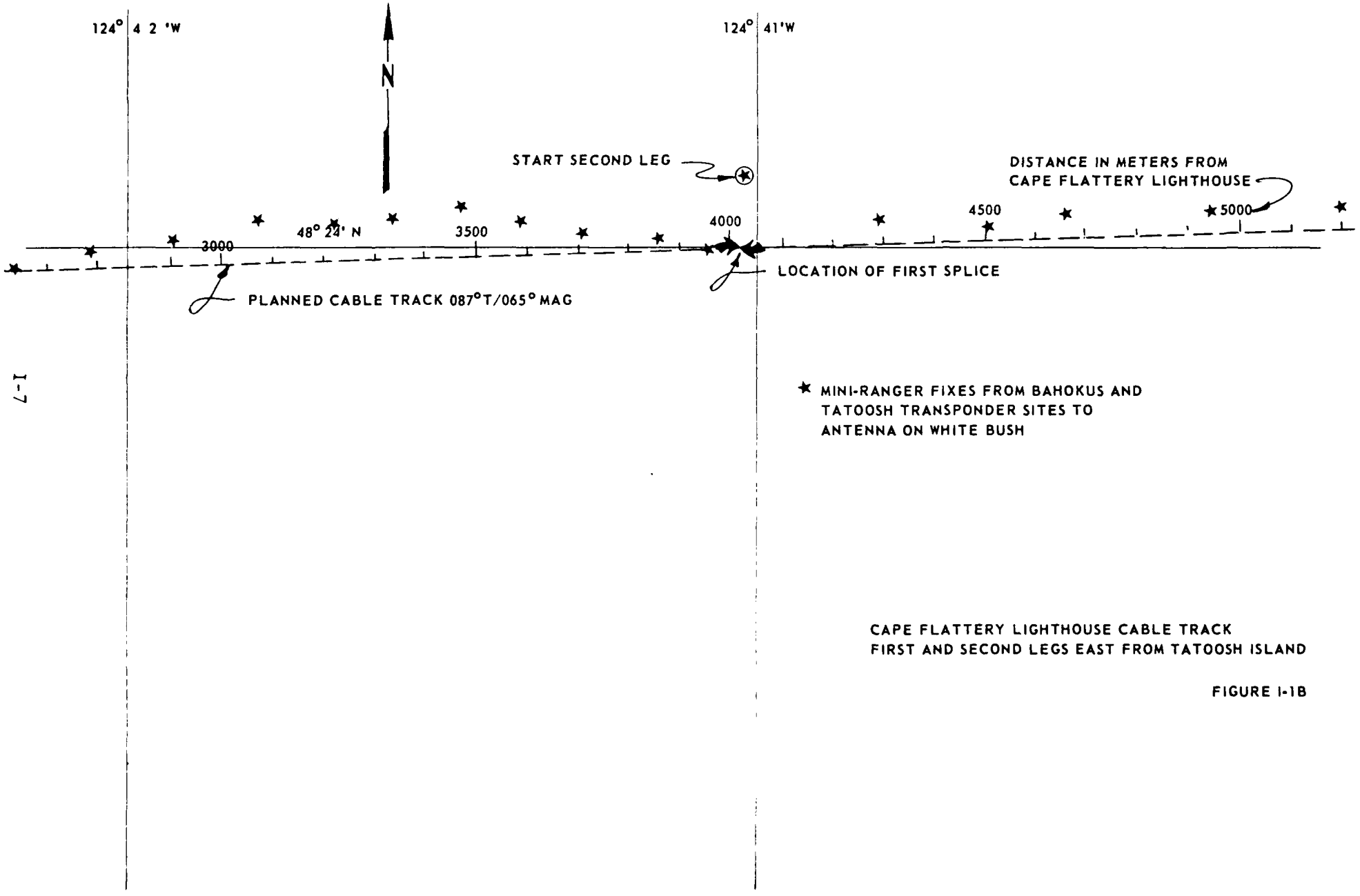
SITE NO. 4 SITE NAME OR DESCRIPTION Cable Landing Site - Neah Bay
MINI-RANGER TRANSPONDER CHANNEL (CODE) One
TRANSIT ZERO ANGLE REFERENCE

SITE LOCATION DETERMINATIONS: Parallel to beach about 20 feet west of power pole - location taken from charts as:
Coordinates: 48° 22' 36.4" North Latitude
124° 37' 40.0" West Longitude



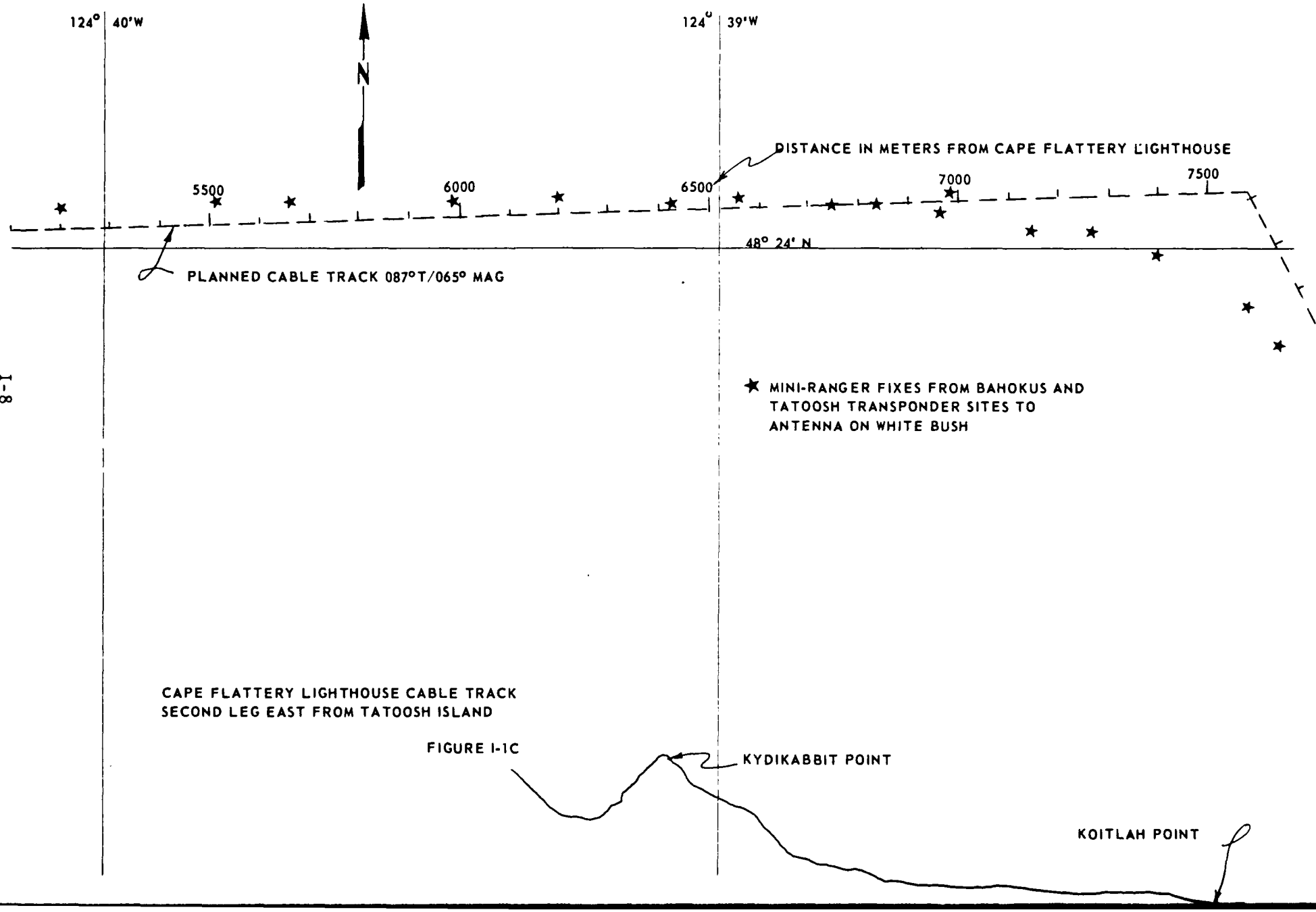
CAPE FLATTERY LIGHTHOUSE CABLE TRACK
FIRST LEG EAST FROM TATOOSH ISLAND

FIGURE I-1A



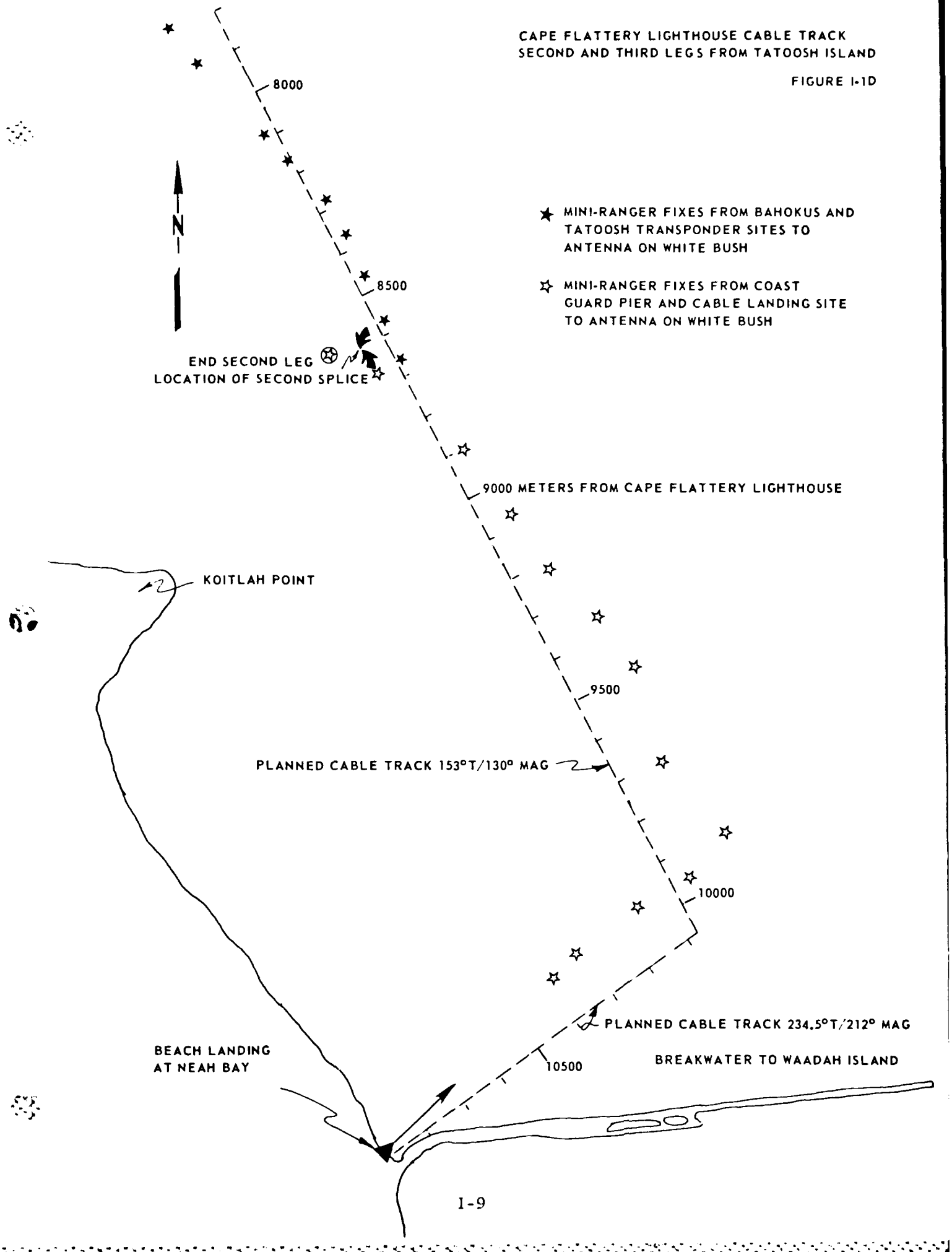
CAPE FLATTERY LIGHTHOUSE CABLE TRACK
FIRST AND SECOND LEGS EAST FROM TATOOSH ISLAND

FIGURE I-1B


124° 40'W
124° 39'W
N
DISTANCE IN METERS FROM CAPE FLATTERY LIGHTHOUSE
5500
6000
6500
7000
7500
48° 24' N
PLANNED CABLE TRACK 087°T/065° MAG
MINI-RANGER FIXES FROM BAHOKUS AND TATOOSH TRANSPONDER SITES TO ANTENNA ON WHITE BUSH
CAPE FLATTERY LIGHTHOUSE CABLE TRACK
SECOND LEG EAST FROM TATOOSH ISLAND
FIGURE I-1C
KYDIKABBIT POINT
KOITLAH POINT

CAPE FLATTERY LIGHTHOUSE CABLE TRACK
SECOND AND THIRD LEGS FROM TATOOSH ISLAND

FIGURE I-1D



CAPE FLATTERY LIGHTHOUSE CABLE FROM TATOOSH ISLAND TO SECOND SPLICE
DISTANCES FROM MINI-RANGER STATIONS IN METERS

TIME OF DAY	BAHOKUS SITE 2 CHAN 2	TATOOSH SITE 3 CHAN 3	TIME OF DAY	BAHOKUS SITE 2 CHAN 2	TATOOSH SITE 3 CHAN 3	TIME OF DAY	BAHOKUS SITE 2 CHAN 2	TATOOSH SITE 3 CHAN 3	TIME OF DAY	BAHOKUS SITE 2 CHAN 2	TATOOSH SITE 3 CHAN 3
0945	4880	355	1353	3692	2492	1440	3140	3844	0547	3845	6770
1308	4862	412	1354	3673	2548	1445	3178	3858	0548	3863	6825
1312	4861	417	1355	3650	2603	2113	3135	3900	0549	3903	6884
1314	4882	430	1356	3628	2136	2136	3138	3904	0550	3925	6940
1315	4887	438	1357	3608	2694	0505	3264	3961	0551	3956	7006
1316	4902	448	1358	3588	2751	0510	3188	4049	0552	4002	7080
1317	4907	467	1359	3567	2808	0511	3168	4057	0553	4024	7117
1318	4888	502	1400	3551	2861	0512	3155	4079	0554	4047	7190
1319	4877	547	1401	3530	2911	0513	3138	4128	0555	4071	7248
1320	4850	597	1402	3505	2972	0514	3135	4195	0556	4086	7297
1321	4818	641	1403	3496	3010	0515	3132	4309	0557	4102	7338
1322	4754	723	1404	3478	3061	0516	3130	4399	0558	4114	7404
1323	4711	784	1405	3463	3108	0517	3133	4479	0559	4122	7442
1324	4679	857	1406	3445	3158	0518	3133	4569	0600	4122	7476
1325	4649	925	1407	3427	3212	0519	3134	4653	0601	4123	7512
1326	4583	1020	1408	3407	3261	0520	3148	4785	0602	4127	7562
1327	4538	1085	1409	3385	3300	0521	3148	4838	0603	4125	7601
1328	4492	1150	1410	3368	3347	0522	3162	4907	0604	4126	7622
1329	4450	1207	1411	3348	3396	0523	3171	4998	0605	4128	7656
1330	4404	1278	1412	3325	3448	0524	3184	508°	0606	4128	7690
1331	4353	1348	1413	3307	3495	0525	3201	5175	0607	4127	7719
1332	4320	1417	1414	3291	3528	0526	3217	5253	0608	4126	7746
1333	4275	1467	1415	3269	3587	0527	3234	5329	0609	4126	7765
1334	4244	1522	1416	3251	3627	0528	3252	5395	0610	4112	7790
1335	4230	1572	1417	3233	3674	0529	3275	5486	0611	4095	7799
1335	4195	1653	1418	3211	3706	0530	3302	5559	0612	4084	7820
1336	4166	1702	1419	3192	3748	0531	3331	5646	0613	4082	7835
1337	4132	1742	1420	3167	3799	0532	3360	5726	0614	4078	7848
1339	4076	1805	1421	3153	3837	0533	3390	5800	0615	4075	7840
1340	4049	1834	1422	3135	3871	0534	3418	5884	0616	4057	7834
1341	4006	1893	1423	3137	3838	0535	3452	5953	0617	4040	7835
1342	3970	1939	1424	3137	3808	0536	3478	6021	0618	4066	7830
1343	3935	1992	1425	3146	3773	0537	3512	6086	0619	4066	7821
1344	3899	2044	1426	3141	3747	0538	3540	6162	0620	4067	7809
1345	3865	2093	1427	3135	3740	0539	3580	6230	0621	4052	7805
1346	3838	2144	1428	3128	3737	0540	3608	6290	0622	4045	7807
1347	3818	2188	1429	3126	3741	0541	3644	6361	0623	4042	7809
1348	3798	2236	1430	3132	3752	0542	3681	6431	0624	4039	7804
1349	3771	2295	1432	3127	3794	0543	3707	6495	0625	4040	7798
1350	3758	2348	1434	3114	3780	0544	3739	6579	0626	4044	7797
1351	3727	2399	1436	3112	3825	0545	3765	6619	0800	4050	7819
1352	3715	2440	1438	3135	3838	0546	3808	6698			

CAPE FLATTERY LIGHTHOUSE CABLE FROM NEAH BAY TO SECOND SPLICE
DISTANCES FROM MINI-RANGER STATIONS IN METERS

TIME OF DAY	BEACH AT NEAH BAY SITE 4 CHAN 1	COAST GUARD PIER SITE 5 CHAN 3	TIME OF DAY	BEACH AT NEAH BAY SITE 4 CHAN 1	COAST GUARD PIER SITE 5 CHAN 3	TIME OF DAY	BEACH AT NEAH BAY SITE 4 CHAN 1	COAST GUARD PIER SITE 5 CHAN 3	TIME OF DAY	BEACH AT NEAH BAY SITE 4 CHAN 1	COAST GUARD PIER SITE 5 CHAN 3
1700	514	2041	1722	1054	2002	1731	1307	2577	1741	1722	3195
1705	512	2046	1723	1086	2047	1732	1350	2641	1742	1742	3229
1714	548	2031	1724	1112	2117	1733	1401	2716	1743	1744	3241
1715	600	2011	1725	1136	2184	1734	1446	2781	1744	1746	3243
1716	665	1987	1726	1162	2247	1735	1485	2831	1745	1746	3242
1717	755	1955	1727	1189	2306	1736	1535	2909	1746	1745	3244
1718	832	1925	1728	1225	2377	1737	1583	2973	1750	1745	3240
1719	884	1904	1729	1244	2438	1738	1620	3032	1755	1762	3245
1720	942	1888	1730	1272	2503	1739	1659	3097	1852	1750	3222
1721	1011	1914				1740	1695	3153			

END

DTIC

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